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Are Nitrided Cutting Tools Successful?

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THE performance of a cutting tool is governed largely by its heat-treatment. In fact, most tools owe their success or failure to their heat-treatment, which takes second place to no other operation required in the construction of a tool, including the selection of the steel itself. It has often been shown in the past, and is shown again in this article, that an ordinary grade of cutting steel can be improved twofold or more by a special heat-treatment.

Within the last decade the nitriding of special alloy steels made for the purpose has gained an enviable reputation in the field of metallurgy. This process has been discussed extensively and much has been written about its value when applied to a long list of component parts of mechanisms. Included in this list are many parts that rotate or slide in constant frictional contact and that are required to be unusually hard in order to prevent rapid wearing of the part. The process has been applied to gages, stamping and bending dies, and many other parts closely related to shops and commercial products. In each case, the article to be nitrided has been fabricated from one of a number of special nitriding steels now on the market.

In view of the excellent results and cost reductions derived from nitriding special parts, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and several of its subsidiary plants have conducted a series of experiments for several years to determine the practicability of applying the process of nitriding to various types of cutting tools, such as drills, reamers, turning and boring tools, etc. The first experiments with these tools were unfavorable, as compared to regular high-speed or cobalt steel tools or the various carbide tools for cast iron or non-ferrous materials.

Experiments Extending Over a Period of Several Years Show Advantages and Limitations of Nitrided Cutting Tools in Regular Shop Practice

The first tests were made with reamers and form cutters made from special brands of nitriding steels and nitrided according to the manufacturer's recommendations. Other tools were nitrided for longer and shorter periods. A comparison was made with the regular high-speed tools—not nitrided—on materials such as Micarta and bronze. At the conclusion of the investigation, it was found that the high-speed tools held up from two to three times longer than the nitrided tools, the latter chipping and dulling faster, due to the hardness of the case.

No attempt was made to nitride high-speed tools at that time, as considerable doubt existed in the minds of those interested in nitriding as to the practicability of applying the process to high-speed steel, due to the absence of aluminum in its com-

position, as well as the absence of molybdenum in many brands. As properties considered necessary to secure a satisfactory case depth were provided by these two elements, it is obvious that the possibilities of nitriding high-speed steel could easily be overlooked while searching for a better grade of nitriding steel for cutting tools.

Fortunately, as a coincidence, an occasion arose in the shop requiring a super-hard drill for drilling the refrigerator part shown in Fig. 1, which is made of special molded material. The production on this part was well over a thousand a day. A 1/4-inch hole had to be drilled through the piece, removing a 1/16-inch wall in the center of the molded hole, which was slightly smaller than the drill diameter. As the hole had a very close tolerance, the operator experienced trouble in retaining a sufficiently sharp cutting edge on the drill and in keeping the drill from wearing under size. This necessitated an additional reaming operation. Many types and brands of drills were tried on this job, including drills tipped with tungsten carbide. Slightly better results were obtained with the latter drills, but they continued to wear in back of the tip, causing an undermining of the tip and early failure. The drill costs also rose rapidly.

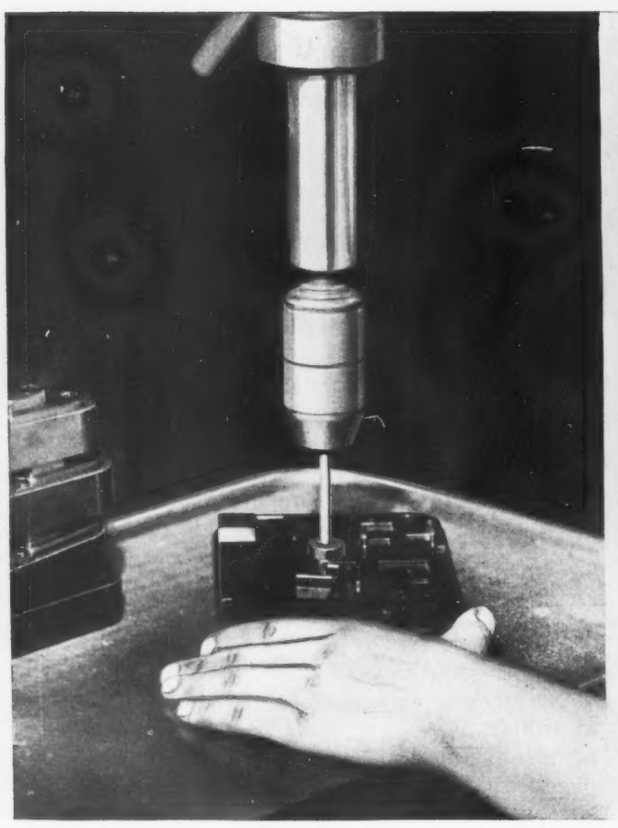
As a last resort, a number of 1/4-inch regular high-speed drills were placed in a nitriding heat along with a miscellanous assortment of regular work, including pins, ratchets, bushings, dies, etc., and nitrided for twenty-five hours. The drills were then polished on a buffing wheel and reground to remove any brittleness from the cutting edge. When the performance of the nitrided drills was checked, the results far exceeded those anticipated, the drills holding up from six to eight times longer than before nitriding. The same ratio was maintained after the drills had been resharpened a number of times, proving that renitriding was unnecessary after each grind.

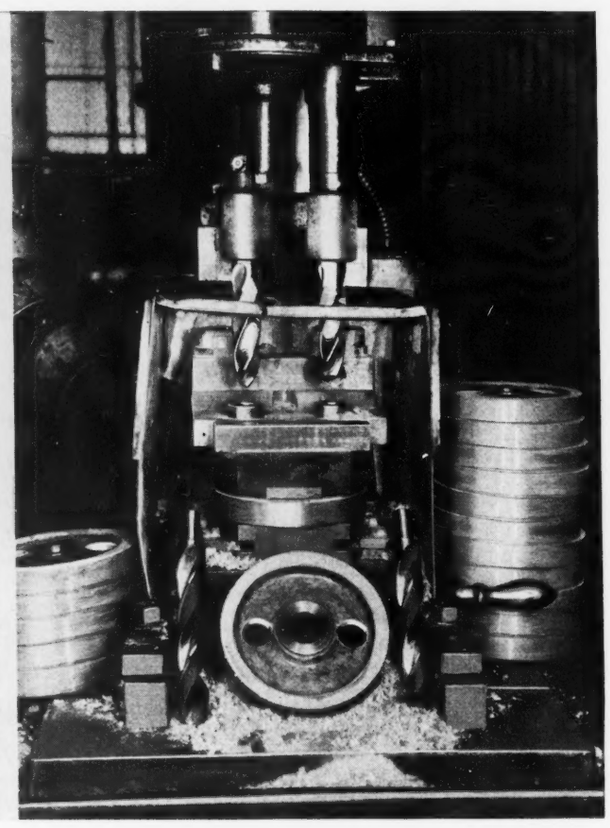
Growth Resulting from Nitriding Restores Worn Drills to Size

In addition to the increased production obtained by nitriding high-speed steel drills as described, it was found that growth in the drill after nitriding increased the diameter from 0.001 to 0.0015 inch. The depth of case obtained was between 0.012 and 0.014 inch, with the core of the drill remaining sufficiently soft to prevent breakage. As a further result of these findings, over one hundred 1/4-inch

Fig. 1. Drilling Molded Part with 1/4-inch High-speed Drill that Stood up Six to Eight Times Longer After it had Been Nitrided

Fig. 2. These High-speed Steel Drills Drilled 2000 Micarta Gear Blanks per Grind after Nitriding, Grinding, and Chromium-plating





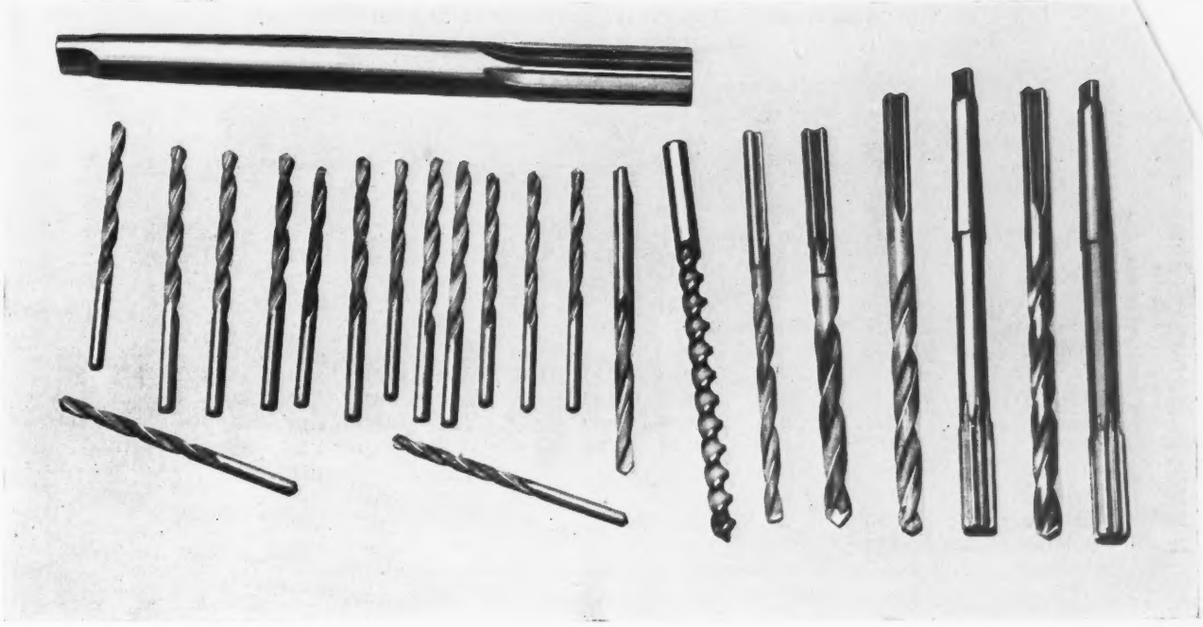


Fig. 3. Examples of High-speed Steel Drills and Reamers that were Made More Durable by Nitriding

drills that had been worn under size were brought back to their former size by nitriding, and again put back into active use.

It is interesting to note that several dozen nitrided 1/4-inch drills, when worn under size on this job, were renitrided twice with very good results. These good results apparently ended with the third nitriding. The Vickers Brinell hardness of the high-speed drills was raised from 700, on the drills as taken from stock, to approximately 1050-1100. A saving of over $500 a year was effected on this application, including the cost of new drills, reclamation of worn drills from time to time, and the elimination of a reaming operation.

Drills Used on Bronze and Micarta Parts Produce Two or Three Times More Parts per Grind after Nitriding

Tests in cutting bronze and Micarta with high-speed drills and drills made from regular nitriding steels, as previously described, showed that the performance of the stock high-speed drills was several times better than that of the drills made from regular nitriding steel. The worn high-speed drills employed in these tests were next nitrided and run under similar conditions. It was found that these drills produced from two to three times more pieces per grind than before nitriding, or from four to six times as many pieces as the regular nitriding steels. As a result, the nitriding of high-speed drills was introduced on many similar applications.

Nitriding, Grinding, and Chromium-Plating of Drills Increases Production per Grind from 250 to 2000

Another profitable application of nitrided high-speed drills is shown in Fig. 2. This work consists of drilling two 1 1/8-inch diameter clearance holes in a gear blank of "Duck Micarta." Previous to the use of nitrided high-speed steel drills, the regular stock high-speed drills drilled about 250 gears per grind. This meant that considerable time was lost in changing and resharpening drills. After nitriding the same drills, the average number of pieces per grind was doubled. It was discovered, however, that, due to the rapid drilling and the abrasive nature of the material, the extreme cutting edges of the drills chipped slightly.

To determine the cause of this spalling or chipping, experiments were conducted with several test pieces of nitrided high-speed steel. It was found that there existed on the outside of the regular nitrided case, which was about 0.012 to 0.014 inch deep, a brittle scale from 0.001 to 0.002 inch deep. This scale showed an irregular indentation of the Vickers diamond point hardness tester. After removing 0.002 inch by grinding, the true nitrided case was reached. As a further check, 0.002 inch was ground from the inside flutes of the drills. This eliminated the chipping and, in addition, increased the number of pieces per grind to 1500. This production was further increased to nearly 2000 blanks per grind by chromium-plating the drills, thus permitting a smoother flow of the chips with less friction. In this way, substantial economies were effected on this job.

Another application of nitrided drills that reduced drill costs approximately 75 per cent is shown in the heading illustration. The No. 29 drills used in this case were nitrided for ten hours, giving a case approximately 0.007 to 0.008 inch deep and a larger cross-section of soft core, thus reducing the danger of breakage due to brittleness. The part drilled in this case is a Micarta refrigerator wedge,

Table 1. Chemical Analysis and Heat-Treatment of Special Alloy and Nitriding Steels Used for Test Cubes

Test Cube No.	Type of Steel	C	Mn	P	S	Si	Ni	Cr	Va	W	Co	Mo	Al
1	Cold-rolled.....	0.08 0.16	0.60 0.90	0.09 0.13	0.10 0.18	....	....	....	....	....	....	....	....
2	High-speed.....	0.60 0.75	0.15 0.40	Max. 0.04	Max. 0.04	Max. 0.40	....	3.00 4.50	0.75 1.50	17.00 19.00	....	....	....
3	Nitriding.....	0.25 0.35	0.40 0.70	Max. 0.04	Max. 0.04	Max. 0.30	....	....	....	....	....	0.60 1.00	1.00 1.50
4	High-speed.....	Same as Block No. 2											
5	Cobalt.....	0.65 0.70	0.25 0.35	.... 0.03	.... 0.03	0.20 0.40	....	4.00 4.25	0.90 1.10	17.00 18.00	4.50 5.00	0.40 0.50	....
6	Cobalt.....	0.70	0.35	0.03	0.03	0.40	....	4.25	1.10	18.00	5.00	0.50	....
7	Cobalt.....	0.70	0.35	0.03	0.03	0.40	....	4.25	1.10	18.00	5.00	0.50	....
8	Cobalt.....	0.70	0.35	0.03	0.03	0.40	....	4.25	1.10	18.00	5.00	0.50	....
9	Nitriding.....	0.75	0.20	....	....	0.41	0.12	4.28	1.05	.....	....	9.61	....
10	Nitriding.....	0.75	0.20	....	....	0.41	0.12	4.28	1.05	.....	....	9.61	....
11	Nitriding.....	0.75	....	....	....	....	....	4.50	2.00	18.50	....	0.50	....
12	Nitriding.....	0.75	....	....	....	....	....	4.50	2.00	18.50	....	0.50	....
13	Nitriding.....	Same as Block No. 3											
14	High-speed.....	Same as Block No. 4											
15	Cobalt.....	Same as Block No. 8											
16	Cobalt.....	Same as Block No. 8											
17	Nitriding.....	1.00 1.15	0.20 0.35	....	....	0.30 0.60	....	11.00 13.00	0.15 0.25	....	....	0.75 1.00	....
18	Nitriding.....	1.00 1.15	0.20 0.35	....	....	0.30 0.60	....	11.00 13.00	0.15 0.25	....	....	0.75 1.00	....
19	Nitriding.....	1.00 1.10	0.10 0.30	....	....	0.20 0.40	....	1.10 1.30	....	....	....	1.10 1.50	....
20	Nitriding.....	1.10	0.30	....	....	0.40	....	1.30	....	.....	....	1.50	....

HEAT-TREATMENT

Nos. 1, 2, 3, 5, 7, 9, 11, 17 and 19 were not heat-treated.

Nos. 4 and 14	Preheat 600°–1750° F.	Quench 2400° F.	Draw 1000°–1100° F.,	for 1 hour
Nos. 6, 8 and 15	Preheat 600°–1400° F.	Quench 2350° F.	Draw 1000°–1100° F.,	for 2 hours
No. 10	Preheat 1550° F.	Quench 2250° F.	Draw 1000° F.,	for 1 hour
No. 12	Preheat 1550°–1600° F.	Quench 2350° F.	Draw 1100° F.,	for 2 hours
No. 13	Preheat 1550°–1600° F.	Quench 1600° F.	Draw 1100° F.,	for 1 hour
No. 16	Preheat 600°–1400° F.	Quench 2350° F.	Draw 1000°–1100° F.,	for 2 hours
No. 18	Preheat 2000° F.	Quench 2000° F.	Draw 1000° F.,	for 1 hour
No. 20	Preheat 1550° F.	Quench 1550° F.	Draw 1000° F.,	for 1 hour

Table 2. Vickers Hardness and Growth of Special Test Blocks

Test Cube No.	Growth of Blocks	Surface Hardness (Vickers Test)			Hardness at Different Depths Ranging from 0.002 to 0.020 Inch (Vickers Test)									
		Before Heat-Treatment	After Heat-Treatment	After Nitriding	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
1	0.001 to 0.002	146	...	243	223	213*	213	213	213	213	213	213	213	213
2	0.0015	207	...	1073	748	592	454	340	276	249	243	238*	238	238
3	0.001 to 0.002	198	...	1030	940	732	557	420	328	261	221	193*	193	193
4	0.0015 to 0.002	207	705	775	1088	1003	884	802	757*	757	757	757	757	757
5	0.001	298	...	610	470	374	306	300	296	294	292*	292	292	292
6	0.00065 to 0.0008	298	841	1073	1058	884	831*	831	831	831	831	831	831	831
7	0.0013 to 0.0015	294	...	677	692	622	398	320	284	278*	278	278	278	278
8	0.0008 to 0.0011	294	873	1175	1152	1003	918	831*	831	831	831	831	831	831
9	0.0011	221	...	732	628	483	320	272	227	224	219	215	210*	210
10	0.0014	221	873	1200	1186	1119	952	802*	802	802	802	802	802	802
11	0.0006 to 0.0008	256	...	766	748	684	526	359	284	258*	258	258	258	258
12	0.0006 to 0.0008	256	821	1103	1088	964	862	793	784	775*	775	775	775	775
13	0.0012 to 0.0015	210	259	1030	940	784	574	430	333	272	251*	251	251	251
14	0.0012 to 0.0014	269	873	1058	1073	1003	884	802	775	766*	766	766	766	766
15	0.0010 to 0.0015	294	873	1175	(Hardness after drawing 1/2 hour at 650° C., 1030)									
16	0.0009 to 0.0010	294	873	1175	(Hardness after drawing 1/2 hour at 650° C., 1058)									
17	0.0009 to 0.0011	197	...	426	335	241	204	201	196	193*	193	193	193	193
18	0.0047 to 0.0048	197	642	775	766	656	574	536	528	516*	516	516	516	516
19	0.0007	237	...	438	420	395	371	335	306	286	267	263	254*	254
20	0.0008	237	496	616	635	628	598	557	552	521	506	491	483*	483

*This reading taken at full depth of case; following readings merely show core hardness.

Table 3. Results of Drilling Tests Made to Determine Value of Nitriding*

Drill No.	Type of Drill	Total Inches Drilled	Condition of Drill
	1/4-inch Drill in Brass		
4	HS not nitrided.....	345	Worn
4	HS nit. 25 hours....	39	Worn
6	Cobalt nitrided	258	Worn
8	Cobalt nitrided	687	Worn
†	Nit. by Manf'r.	592.5	Chipped badly
4	Nit. and drawn 650° C.	331.5	Worn
6	Nit. and drawn 650° C.	438	Worn
8	Nit. and drawn 650° C.	502	Worn
	1/4-inch Drill in Copper		
4	HS not nitrided.....	115	Worn
4	HS nitrided	4	Worn and broken
6	Cobalt nitrided	41	Worn
8	Cobalt nitrided	18	Chipped
†	Nit. by Manf'r.	58	Worn
4	Nit. and drawn 650° C.	43	Worn and broken
6	Nit. and drawn 650° C.	33	Chipped
8	Nit. and drawn 650° C.	40	Chipped
	3/8-inch Drill in Cast Iron		
4	HS not nitrided.....	600	Worn
4	HS nitrided	21	Chipped
6	Cobalt nitrided	314	Worn and chipped
8	Cobalt nitrided	10	Chipped
†	Nit. by Manf'r.	90	Chipped
4	Nit. and drawn 650° C.	27	Chipped
6	Nit. and drawn 650° C.	23	Chipped
8	Nit. and drawn 650° C.	2	Chipped
	"Total Inches Drilled" represents amount drilled per one grind.		

Drill No.	Type of Drill	Total Inches Drilled	Condition of Drill
	3/8-inch Drill in Boiler Plate		
4	HS not nitrided.....	100	Worn
4	HS nitrided	9	Worn and chipped
6	Cobalt nitrided	8	Chipped
8	Cobalt nitrided	4	Chipped
†	Nit. by Manf'r.	6	Chipped
4	Nit. and drawn 650° C.	6	Chipped
6	Nit. and drawn 650° C.	2	Chipped
8	Nit. and drawn 650° C.	4	Chipped
	3/8-inch Drill in Ebony Asbestos		
4	HS not nitrided.....	70	Worn
4	HS nitrided	100	Worn
6	Cobalt nitrided	150	Worn
8	Cobalt nitrided	75	Worn
†	Nit. by Manf'r.	50	Worn
4	Nit. and drawn 650° C.	100	Worn
6	Nit. and drawn 650° C.	100	Worn
8	Nit. and drawn 650° C.	200	Worn
	1/4-inch Drill in Moldarta		
4	HS not nitrided.....	150	Diameter worn
4	HS nitrided	1800	Diameter worn
†	Nit. by Manf'r.	2100	Diameter worn
†	Special nit. by Mf'r..	2300	Diameter worn
†	Spec. 3 lip nit.	4076	Diameter worn
	3/8-inch Drill in Slate		
4	HS not nitrided.....	26	Worn
4	HS nitrided	12	Worn and broken
4	Nit. and drawn 650° C.	1	Worn

*The drills included in this table have the same chemical analysis and heat-treatment as the test blocks of corresponding numbers in Table 1.
†Steel nitrided by manufacturer: hence has no corresponding test block number.

the thickness of the portion drilled being 1 1/4 inches.

Other Successful Applications of Nitrided High-Speed Steel Tools

Some of the other successful applications of nitriding to high-speed steel tools include form cutters for milling a radius on Micarta strips; reamers for reaming permanent mold, bronze alloy; reamers for brass castings, bronze bushings, and screw machine work; saw cutter for milling grooves in bronze bushings; saw cutter for sawing Micarta strips; and taps for tapping resinous materials. Nitrided drills were also used on several special jobs, such as drilling plate glass and 1/16-inch thick Stellite, using turpentine as a lubricant. Care must be taken to guard against nitriding any tools made of carbon steel, as such applications have proved unsatisfactory. Mistakes in this respect can be prevented by subjecting the material to the spark test before nitriding.

In view of the results obtained, it was deemed advisable to continue the investigation. Accordingly a series of supplementary tests was undertaken. These tests were made with various types of nitrided drills to determine their merits in drilling other non-ferrous and ferrous materials such as asbestos, slate, cast iron, steel, copper, etc. (see Table 3). Preliminary to these tests, a series of twenty test cubes were fabricated and nitrided, in order to learn more of the growth, depth of case, and hardness of the various types of steels subjected to the nitriding process and, in addition, to provide data for use in selecting drills of the kind best suited for the tests.

Test Cubes Employed in Selecting Cutting Tool Materials for Nitriding

The various materials selected for the test cubes consisted of high-speed steel, current nitriding steels, and cold-rolled steel, a test cube of the latter material being included to permit noting the growth, as this material is impervious to nitriding, although favorably adapted to casehardening. The chemical analysis of the different test blocks and also the heat-treatment to which the individual blocks were subjected previous to nitriding are given in Table 1. The brands of steel and the makers' names are not given, but the blocks are numbered from 1 to 20 for identification purposes.

The finished size of the blocks before nitriding was 1.000 by 1.000 by 1.000 inch. This size was

selected as the most suitable for comparative growth tests on three sides. The twenty blocks were first shaped from the rough material as received, sufficient material having been removed to eliminate the decarburized scale, or outer surface. The blocks not requiring heat-treatment before nitriding were machined to 1.020 inches over all to allow for grinding to the finished size before nitriding. Those blocks requiring heat-treatment before nitriding were machined to 1.0625 inches over all, allowing for the removal of 1/32 inch from each side, with the exception of the cobalt steel blocks, which were made 1.125 inches, allowing for the removal of 1/16 inch of stock per side. This amount of material was removed by grinding, in order to eliminate the decarburized surface caused by the heat-treating process.

The number of each block was stamped deeply in one face immediately upon being roughed out, in order to avoid any error in future identification. Following heat-treatment and grinding to the finished size of 1.000 inch over all, the blocks were nitrided for a period of twenty-five hours, allowing four hours to bring the work up to 535 degrees C. After bringing the work up to this temperature in the nitriding furnace, it was held there for a period of sixteen hours. The temperature was then raised from 535 to 570 degrees C. and held there for a period of nine hours, making the total nitriding time twenty-five hours. The gas dissociation at the 535-degree temperature was 30 per cent, and at the 570-degree temperature, 50 per cent. The gas was then left on and the work allowed to cool slowly to 100 degrees C. for 3 1/2 hours.

After nitriding, the blocks were buffed slightly on a soft rag wheel to remove surface dirt, and then checked for growth. Finally, a series of ten steps, 0.002 inch deep by 1/16 inch wide, was ground on one side of each block to determine the range of hardness and the depth of the nitrided case. A Vickers Brinell reading was taken on each step, as recorded in Table 2.

Tests Show Advantages of Nitriding Tools Used on Resinous Materials

As a result of the data obtained on the test blocks, the following types of drills were selected for testing: Both regular and nitrided high-speed drills, regular heat-treated and nitrided cobalt steel drills, and several drills nitrided and furnished by drill manufacturers. The comparative results of the drill tests on various materials are outlined in Table 3. The test drill numbers correspond with the numbers of the test blocks given in Tables 1 and 2. The material and previous heat-treatment of each drill is the same as that of the block bearing a corresponding number. Some of the drills were drawn to 650 degrees C. for one-half hour and allowed to cool in lime after being nitrided. The results that were obtained with these drills are also noted in Table 3.

A series of tests was also conducted with nitrided taps for tapping steel, cast iron, brass, and copper. In these tests, considerable difficulty was experienced with spalling and breakage due to brittleness. The results were similar to those obtained by the drill tests. From our experience, we have found that not only drills and taps, but all kinds of tools made of either high-speed or cobalt steels are far superior in cutting efficiency to the same steels "nitrided," for the machining of ferrous materials.

However, we found that all kinds of tools, such as taps, drills, reamers, cutters, etc., made from high-speed or cobalt steels and nitrided, have proved very successful for the machining of nonferrous and particularly resinous materials, as shown by Table 3. Plants machining quantities of these resinous materials should derive considerable benefit in lowered tool costs by properly selecting and nitriding the high-speed and cobalt steel tools used on such materials.

* * *

General Electric to Formulate "New Deal" Plans

A three-day conference to formulate plans for immediately tying in with the National Recovery Act will be held at the General Electric Co.'s plant in Bridgeport, Conn., beginning August 7. More than three hundred officers and distributors of the company from every state in the Union will be present. Gerard Swope, president of the General Electric Co. and chairman of the newly formed Industrial Advisory Committee, will be the principal speaker.

As is well known, the National Recovery Act was, in many respects, anticipated by the plan for cooperation in industry proposed by Mr. Swope more than a year ago as a means for improving conditions in the electrical industry.

* * *

Equitable Transportation Regulations

In a recent editorial, the *Railway Age* states that the conclusion is inescapable that, to establish economic planning in the transportation industry, it is necessary that the following three principles should govern:

"1. Commercial highway and waterway transport must be placed upon the same plane of self-support and taxation as the railways.

"2. There must be similar control of rates and working conditions for all forms of transportation.

"3. Over-expansion and destructive competition must be prevented by the control not only of new services upon, but of investment in, highways and waterways, by the same authority that regulates such services and investment by the railways."

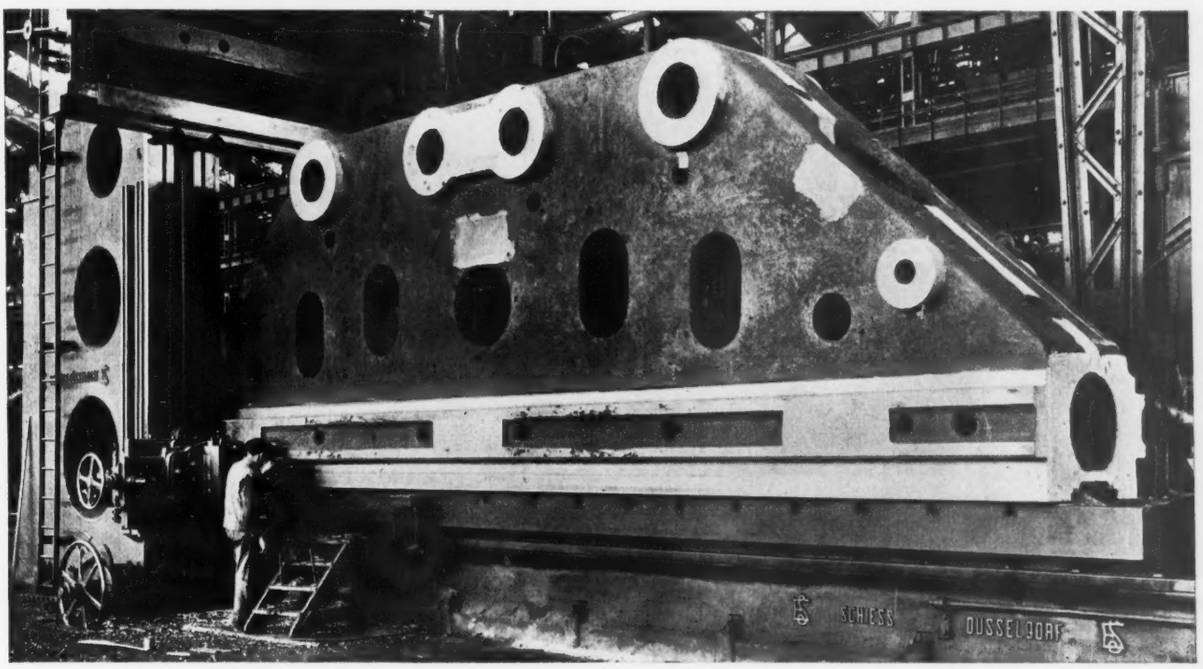
Nothing could be more reasonable. It is only fair that all means of transportation should be placed on an equal footing.

Notes and Comment on Engineering Topics

A novel system for transporting materials such as cement, pulverized coal, and similar products by means of the direct application of compressed air as the carrying or conveying medium has been developed by the Kennedy-Van Saun Mfg. & Engineering Corporation, New York City. The system does not use any compressed air unless material is actually being passed through the transportation line or tube. It is stated that if materials are to be transported at the rate of 5 tons an hour, the cost of air per ton will be no greater than when the transportation is at the rate of 100 tons per hour. This conveying system also has provision for weighing automatically the material discharged.

A remarkable new lubricating oil for steam-turbine lubrication has been brought out by the Standard Oil Co. of Indiana. This oil does not break down or wear out, and is literally guaranteed to last as long as the turbine itself. The oil is the result of extensive laboratory work and prolonged practical tests. The economies effected by this new oil in reducing oil consumption and eliminating forced shut-downs due to lubrication failure are of considerable importance in the industrial field.

Out of a total of sixty-seven elevators in the Empire State Building in New York City, fifty-eight are used for passenger service. The cars are arranged in seven banks of four, eight, or ten cars each, with runs of 128 to 951 feet, at speeds up to 1000 feet per minute. With this arrangement, the elevator system has a total capacity for transporting approximately 15,000 persons one way in thirty minutes.



A Steel Casting Weighing 220,000 Pounds Made at the Krupp Plant in Essen, Germany. This Casting is Part of a 10,000-ton Hydraulic Forging Press, Four of these Castings Being Used in the Assembly

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The four largest motors ever built for any purpose will propel the new French liner *Normandie* recently launched. These motors are rated at 40,000 horsepower, giving the new ship a total horsepower rating of 160,000. The motors are built by Als-Thom, French associate company of the General Electric Co.

Hardened Ways for Machine Tools

How Dovetailed Linings with a Hardened and Ground Wearing Surface and a Soft Base are Forced into Place under High Pressure

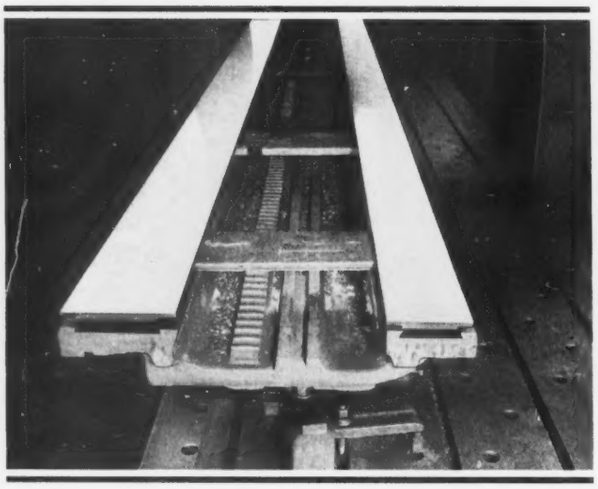
By CHARLES GOLOSMAN

HARDENED and ground steel linings or plates for the ways of machine tools are now recognized by many machine tool builders as an effective means of preventing wear. These linings are being applied largely to heavy-duty production machines. One example of their use is found in the Libby turret lathes built by the International Machine Tool Co., Indianapolis, Ind. The linings are especially applicable on these machines because the ways are made flat and wide to afford ample bearing surface. The method of application to be described is patented.

Formerly, the bearing surfaces of these lathes formed part of the bed casting. This, however, resulted in wear or scoring caused by chips, scale, and sand. Different methods were employed to prevent this, such as chilling the ways and improving the composition of the iron. Hardened strips attached by screws, both sectional and full length, and made of various materials, were also used. These methods increased the wear resistance of the ways, but the method to be described was finally adopted as the most satisfactory.

The lining plate is made in one piece. A dovetail is machined on the bottom of the strip along its entire length. This dovetail fits a corresponding dovetail slot in the machine, and the plate is assembled under high pressure, after which the bearing surface is ground. With this arrangement, the lining is practically a part of the machine bed itself, so that there is little danger of its becoming loose. A set of these plates is shown in Fig. 1 ready to be assembled on a machine bed, the dovetail slots of which have just been planed. In Fig. 2 the assembled machine is shown, with the ways equipped with the dovetailed linings.

Fig. 1. Dovetailed Linings Ready to be Forced into Place on the Machine Ways



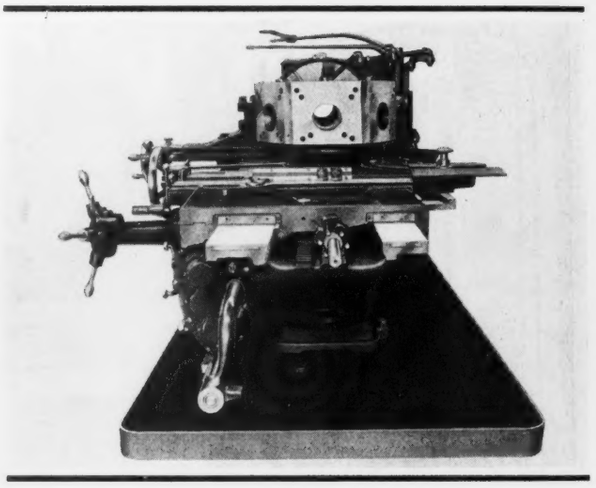


Fig. 2. Libby Turret Lathe, Showing Dovetailed Linings Assembled on the Ways

These plates range in hardness from 75 to 95 Scleroscope. Some of them were inspected after three years' service and it was found that the grinding marks were still visible. The plates are from 6 to 10 inches wide and are made in lengths from 7 to 20 feet. They are composed of two separate strips, hot-rolled together. The bottom or base strip is of a low-carbon composition, while the top or wearing strip has a higher carbon content. After being rolled, the laminated plate is finished by planing. It is then heat-treated and ground. The low-carbon strip is not affected by the heat-treatment; and since it is thicker than the high-carbon strip, makes a soft backing which is easily machined and prevents warping or distortion of the finished ways.

THICKNESSES AND WEIGHTS OF NON-FERROUS ALLOY SHEETS

American Wire or Brown & Sharpe Gage No.	Thickness, Inch	Approximate Weight, Pounds per Square Foot				
		Copper (Cold-Rolled and Annealed)*	Commercial (High) Brass	S A E Aluminum Alloys Nos. 26 and 27	S A E Aluminum Alloy No. 28	Aluminum Commercially Pure (99 to 99.4 Per Cent)
0000	0.4600	21.270	20.270	6.680	6.410	6.490
000	0.4096	18.940	18.050	5.950	5.710	5.780
00	0.3648	16.870	16.070	5.290	5.090	5.140
0	0.3249	15.030	14.320	4.720	4.530	4.580
1	0.2893	13.380	12.750	4.200	4.030	4.080
2	0.2576	11.910	11.350	3.738	3.591	3.632
3	0.2294	10.610	10.110	3.329	3.198	3.234
4	0.2043	9.450	9.000	2.964	2.848	2.880
5	0.1819	8.410	8.010	2.640	2.536	2.565
6	0.1620	7.490	7.140	2.351	2.258	2.284
7	0.1443	6.670	6.360	2.094	2.012	2.034
8	0.1285	5.940	5.660	1.865	1.792	1.812
9	0.1144	5.290	5.040	1.660	1.595	1.613
10	0.1019	4.713	4.490	1.479	1.420	1.437
11	0.0907	4.195	3.996	1.316	1.264	1.279
12	0.0808	3.737	3.560	1.172	1.126	1.139
13	0.0720	3.330	3.172	1.045	1.004	1.015
14	0.0641	2.965	2.824	0.930	0.894	0.904
15	0.0571	2.641	2.516	0.829	0.796	0.805
16	0.0508	2.349	2.238	0.737	0.708	0.716
17	0.0453	2.095	1.996	0.657	0.631	0.639
18	0.0403	1.864	1.776	0.585	0.562	0.568
19	0.03590	1.6600	1.5820	0.5210	0.5010	0.5060
20	0.03200	1.4800	1.4100	0.4640	0.4460	0.4510
21	0.02850	1.3180	1.2560	0.4140	0.3970	0.4020
22	0.02530	1.1700	1.1150	0.3671	0.3527	0.3567
23	0.02260	1.0450	0.9960	0.3280	0.3150	0.3186
24	0.02010	0.9300	0.8860	0.2917	0.2802	0.2834
25	0.01790	0.8280	0.7890	0.2597	0.2495	0.2524
26	0.01590	0.7350	0.7010	0.2307	0.2216	0.2242
27	0.01420	0.6570	0.6260	0.2060	0.1980	0.2002
28	0.01260	0.5830	0.5550	0.1828	0.1756	0.1776
29	0.01130	0.5230	0.4980	0.1640	0.1575	0.1593
30	0.01000	0.4625	0.4406	0.1451	0.1394	0.1410
31	0.00893	0.4130	0.3935	0.1296	0.1245	0.1259
32	0.00795	0.3677	0.3503	0.1154	0.1108	0.1121
33	0.00708	0.3274	0.3119	0.1027	0.0987	0.0998
34	0.00630	0.2914	0.2776	0.0914	0.0878	0.0888
35	0.00561	0.2595	0.2472	0.0814	0.0782	0.0791
36	0.00500	0.2312	0.2203	0.0726	0.0697	0.0705
37	0.00445	0.2058	0.1961	0.0646	0.0620	0.0627
38	0.00397	0.1836	0.1749	0.0576	0.0553	0.0560
39	0.00353	0.1633	0.1555	0.0512	0.0492	0.0498
40	0.00314	0.1452	0.1383	0.0456	0.0438	0.0443

*Copper sheets can also be obtained in fractional-inch thicknesses varying by sixteenths of an inch from 1/16 to 2.

MACHINERY'S Data Sheet No. 256, New Series, August, 1933

Based on information contained in Bureau of Standards Circular No. 39

THICKNESSES AND WEIGHTS OF STEEL AND OPEN-HEARTH IRON SHEETS

U. S. Standard Gage No.*	Standard Weight, Pounds per Square Foot	Equivalent Thickness, Inch, Based on 0.2833 Pound per Cubic Inch	U. S. Standard Gage No.*	Standard Weight, Pounds per Square Foot	Equivalent Thickness, Inch, Based on 0.2833 Pound per Cubic Inch
0000000	20.000	0.4900	20	1.5000	0.0368
000000	18.750	0.4600	21	1.3750	0.0337
00000	17.500	0.4290	22	1.2500	0.0306
0000	16.250	0.3980	23	1.1250	0.0276
000	15.000	0.3680	24	1.0000	0.0245
00	13.750	0.3370	25	0.8750	0.0214
0	12.500	0.3060	26	0.7500	0.0184
1	11.250	0.2757	27	0.6875	0.0169
2	10.620	0.2604	28	0.6250	0.0153
3	10.000	0.2451	29	0.5625	0.0138
4	9.375	0.2298	30	0.5000	0.0123
5	8.750	0.2145	31	0.4375	0.0107
6	8.125	0.1991	32	0.4062	0.0100
7	7.500	0.1838	33	0.3750	0.0092
8	6.875	0.1685	34	0.3438	0.0084
9	6.250	0.1532	35	0.3125	0.0077
10	5.625	0.1379	36	0.2812	0.0069
11	5.000	0.1225	37	0.2656	0.0065
12	4.375	0.1072	38	0.2500	0.0061
13	3.750	0.0919	39	0.2344	0.0057
14	3.125	0.0766	40	0.2188	0.0054
15	2.812	0.0689	41	0.2109	0.0052
16	2.500	0.0613	42	0.2031	0.0050
17	2.250	0.0551	43	0.1953	0.0048
18	2.000	0.0490	44	0.1875	0.0046
19	1.750	0.0429	..	.....	.....

*The United States Standard gage is the recognized commercial standard gage for all uncoated sheet and plate iron and steel. It is a weight rather than a thickness gage. In the original standard, established by an Act of Congress, March 3, 1893, the equivalent thicknesses were based on the weight per cubic inch of wrought iron (0.2778 pound per cubic inch). Since then, however, steel and commercially pure open-hearth iron have come into general use for plates and sheets. To meet present requirements, the original table, therefore, is superseded by the one above, in which the thicknesses are based on a density of steel of 0.2833 pound per cubic inch. As the United States Standard gage is a weight gage based on ounces per square foot, the standard weights in pounds per square foot obviously remain the same as in the original standard.

MACHINERY'S Data Sheet No. 255, New Series, August, 1933

Based on information contained in Bureau of Standards Circular No. 39

Pneumatic Clamping in Milling Fixture Design

Rapid Operation, Increased Accuracy in Milling, and Longer Tool Life are Obtainable with Pneumatic Clamping Methods

By FRANK W. CURTIS, Research Engineer
Kearney & Trecker Corporation, Milwaukee, Wis.

IN a good many instances it is advantageous to substitute compressed air for mechanical operation in milling fixture design. Not the least important of the advantages gained is uniform clamping pressure, which results in greater accuracy in milling. Owing to the elimination of excessive clamping pressures characteristic of other types of fixtures, there is less wear to contend with in the working parts of air-operated fixtures; thus the life of these tools is lengthened. A few outstanding examples will be given in this article to show the adaptability of these fixtures to the ordinary type of milling jobs requiring rapid operation.

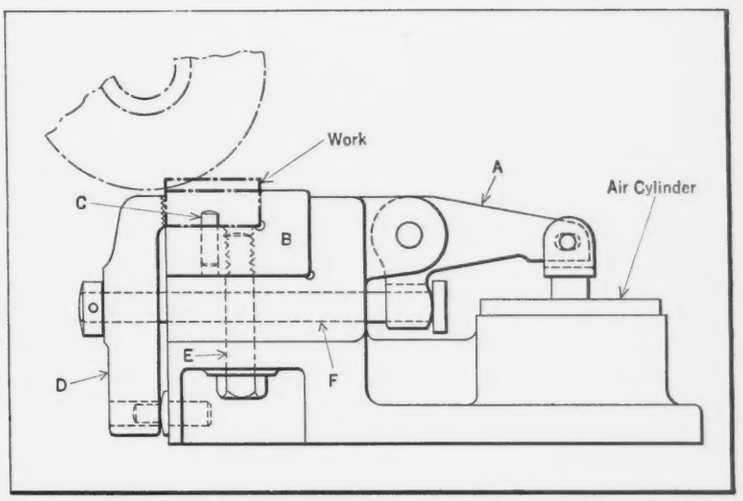


Fig. 1. Air-operated Vise with Interchangeable Jaws. With this Design, the Cylinder Forms No Obstruction to the Milling Cutter

Fixture with Interchangeable Jaws Accommodates a Wide Range of Work

One outstanding advantage of the air-operated fixture shown in Fig. 1 is its low height. No part of the fixture projects above the face of the work to be milled. A 2 to 1 leverage on the plunger of the air cylinder is obtained through the arm *A*, thus increasing the clamping pressure. This fixture, which resembles a vise, lends itself readily for holding a large variety of small parts.

The piece shown in position is a rack bar in which several teeth are milled simultaneously. The bar, held in the block *B*, is located endwise by the pin *C* and is clamped by member *D*. The fixture is made so that the holding block *B* can be interchanged with other blocks by removing two screws *E*. Clamp *D* is actuated by the shaft *F*, which has a shoulder at the right-hand end that comes in contact with the yoke of arm *A*.

In Fig. 2 are shown various applications of this fixture. At *A* is a set-up for straddle-milling a small clevis, and at *B* slots are being milled in a shaft. A small stud is shown at *C* in position to be straddle-milled. In this operation, a V-block and plunger are used for clamping. The arrangement at *D* is used in form-milling a small block. The design of this fixture is also suited for the drilling of small parts. It can be provided with drill bushings, attached either to the interchangeable block or to the body of the fixture.

An efficient method of holding several work-pieces by the use of a floating air cylinder is shown in Fig. 3. The work-pieces, shown at *A*, are cast-iron flanges which are face-milled. The operation is performed in a vertical type milling machine

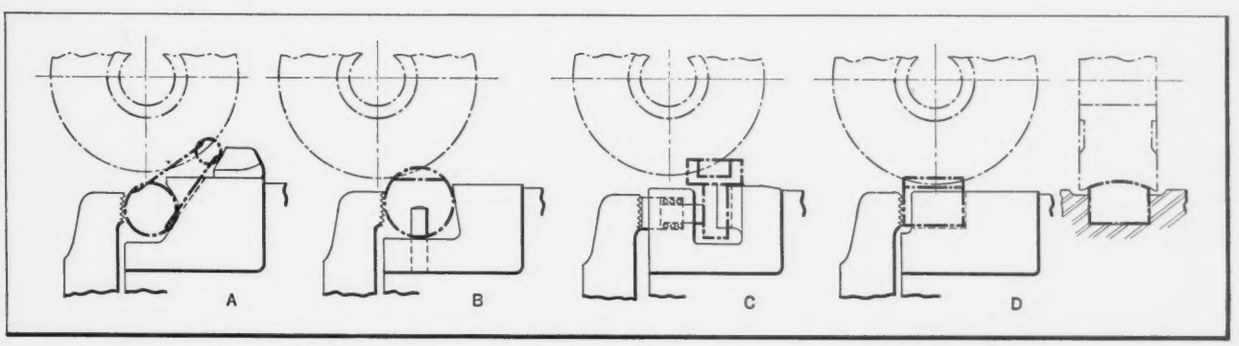


Fig. 2. Application of Interchangeable Jaws that Adapt the Vise in Fig. 1 to a Large Range of Work

with a face milling cutter. The flanges are located on the shouldered studs *B* and the locating plates *C*.

Four hinged clamps *D*—two at each end of the fixture proper—are used for holding the work-pieces securely in position. These clamps are operated through the equalizing bars *E* and *F*. The plunger of the air cylinder is directly connected to the bar *E*, while the bar *F* is connected to the air cylinder by the tie-rod *G*, which passes through an opening in the center of the fixture.

When air pressure is applied, the plunger of the cylinder forces the equalizing bar *E* up to the clamps. Then when the movement of this bar stops, the entire air cylinder moves to the left on the slide *H*, carrying with it tie-rod *G*, which exerts a pull on equalizing bar *F*. This transmits the pressure to all four clamps, thus holding the work-pieces during the milling operation. The method of clamping described has many possible applications in fixture design, and in this case, has increased the production over the method formerly used.

Double-Action Air-Operated Clamp for Continuous Milling in a Reciprocating Fixture

A clamping arrangement, by means of which either of two work-pieces can be clamped by an air cylinder, as desired, enabling one piece to be milled while the other is being loaded, is shown in Fig. 4. The fixture is made with two work-holding stations provided with hardened locating plates *A* on which the work rests. Two fixed jaws *B* are provided for each work-piece. End location is obtained by means of the stop-pins *C*, one for each section of the fixture. The work-pieces are loaded in such a way that the positions of the lugs *D* prohibit through or gang milling.

Clamping is accomplished through the double-acting air cylinder at the left. The piston of the air cylinder operates the clamp-shaft *E* through the hinged lever *G*. The clamp *H* is attached to the shaft *E*, and is mounted in a slide so that it can be shifted from one work-piece to the other. As shown,

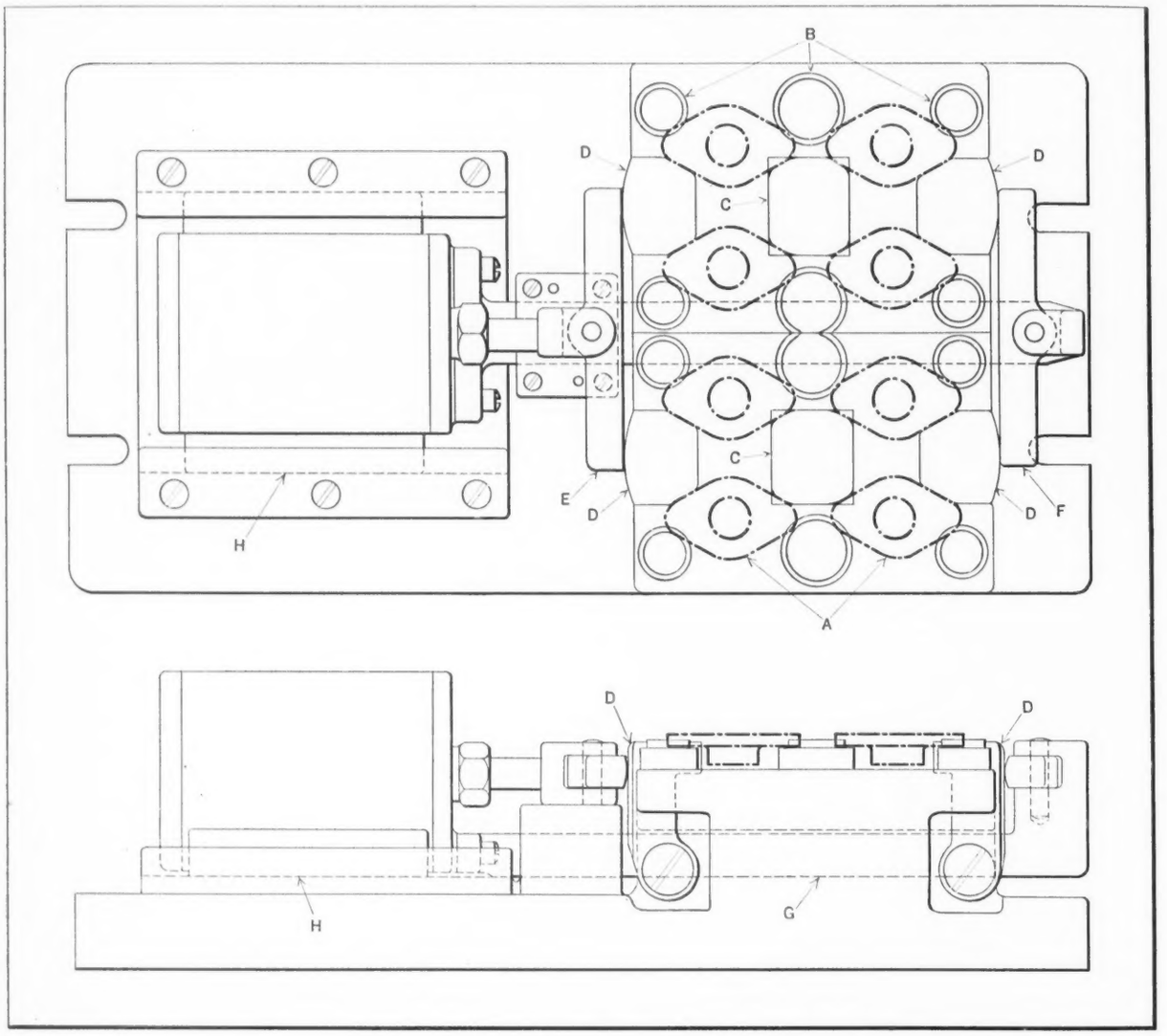


Fig. 3. Clamping Pressure on All These Flanges is Equalized by the Floating Action of the Air Cylinder

the work-piece at the left is clamped. By reversing the action of the air cylinder, the work-piece at the right will be clamped and the one at the left released, so that it can be removed. The opening in the slide in which the sliding clamp *H* fits is covered by a telescoping plate (not shown) to prevent chips from interfering with the clamping.

The machine with which this fixture is used is fitted with automatic table dogs, so that an automatic reciprocating movement is obtained. With this arrangement, the operator merely loads and unloads the work, making possible an output of 200 pieces an hour.

* * *

Successful men rarely are men of unusual brilliance. Wasn't it Theodore Roosevelt who said, "I'm just an average man, but I work at it harder than the average man?"—*Tool Tips*

Holding Power of Nails

The holding power of nails is the subject of a thesis by E. L. Ihl and James Trealor of the University of Pittsburgh. The relative holding power of an ordinary wire nail driven into oak and yellow pine is as 3.4 to 1; the relative holding power of a galvanized nail in the same woods is as 2.5 to 1; and the relative holding power of a cement-coated nail in the same woods is as 1.5 to 1.

In oak, a galvanized nail will hold about 1.25 times the load of an ordinary wire nail, and in pine, 1.6 times the load. Cement-coated nails have from 10 to 15 per cent greater holding power than galvanized nails. In oak, a wire nail has, roughly, 15 per cent less holding power if driven parallel to the grain than if driven crosswise; in pine, under the same conditions, it has 33 per cent less holding power.

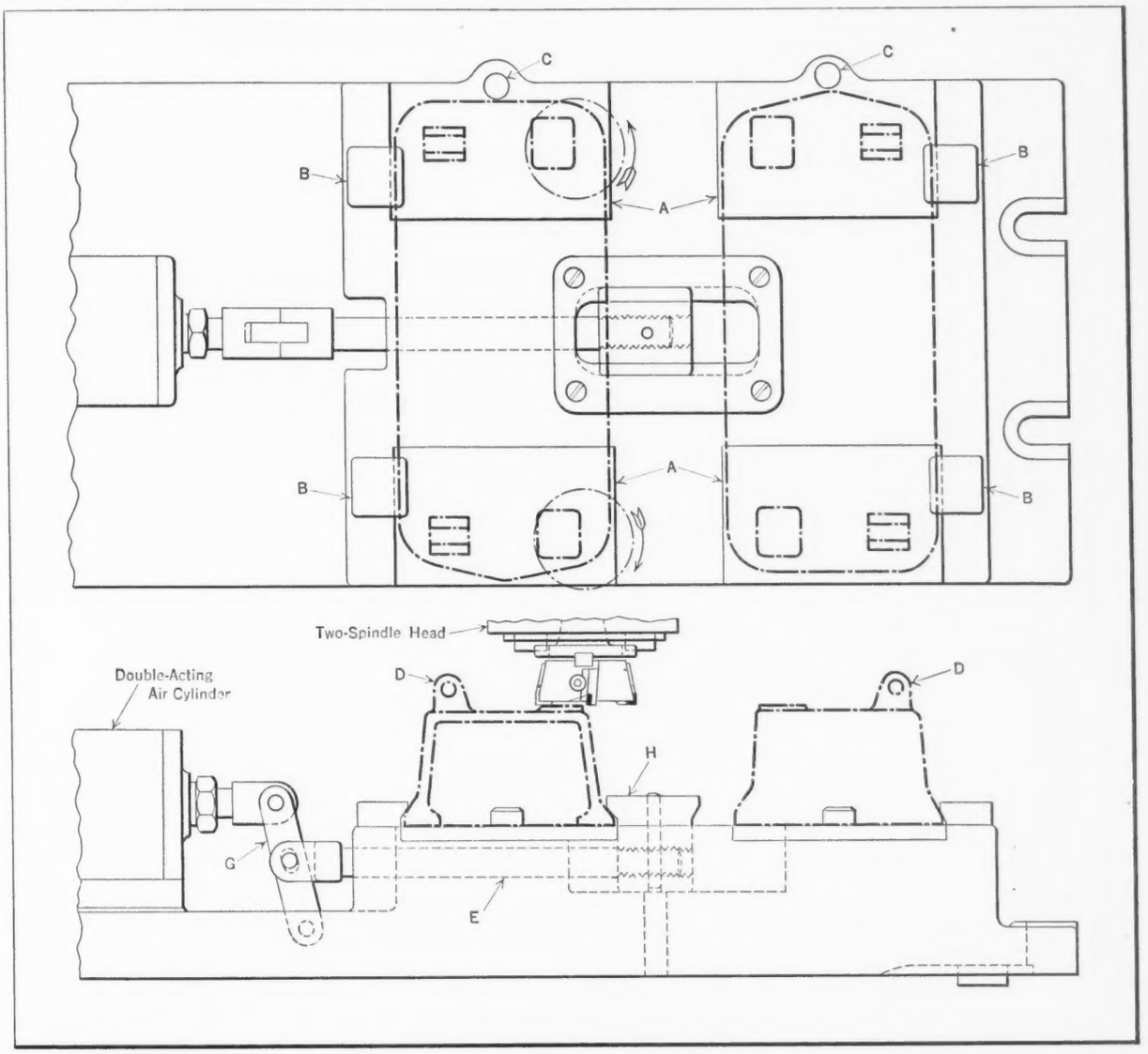


Fig. 4. In This Fixture, a Single Clamp is Reciprocated from One Work-piece to the Other. With This Arrangement, One Piece is Unloaded while the Other is being Milled

Combination Progressive and Transfer Die for an Intricate Stamping

By A. SUTER

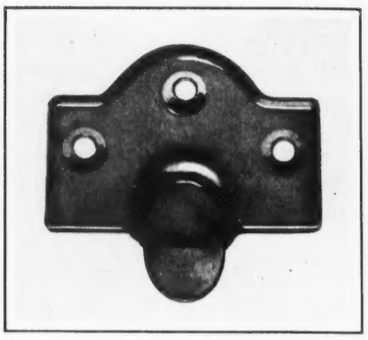


Fig. 1. Trunk Draw-bolt Part Made from Flat Stock in the Die Shown in Fig. 3

THE features of a transfer die can often be combined with those of a progressive die to perform multiple operations that could not be performed in either type of die separately. An excellent example of a combination die of this type is described in this article. This die is comparatively simple in design. It completes one trunk draw-bolt part, like that shown in Fig. 1 and also in the upper left-hand corner of Fig. 3, from flat strip stock.

How the Order of Operations is Arranged

The operations performed in the progressive section of the die, Fig. 3, consist of partial blanking, drawing the lug, piercing three rivet holes, and finish blanking. After these operations have been completed, the blank is carried laterally by a transfer mechanism into an adjoining die, where the part is flanged, the lug hooked, and the three holes countersunk. The strip stock is fed from a coil into the die by means of a roll feed, and as the working parts of the die are automatic, the press is operated continuously.

In order to facilitate construction, the progressive section of the die is made in two parts *A* and *B*, Fig. 3, each of which contains two stations. Stock guides *C* and *D* guide the strip during its passage through the die. Instead of the stripper plate being secured to the die, it is mounted on the punch-block, as indicated at *E* in Fig. 4. This plate is backed up by springs, and as the ram descends, it comes in contact with the top of the stock guides *C* and *D*.

The height of the guides is such that the stripper just makes contact with the strip without setting up excessive pressure. In this way, the stripper serves as a blank-holder and produces a constant pressure on the strip during the entire drawing operation, such as is obtained in a double-action drawing press.

Referring to Fig. 3, openings at both ends of the part are blanked at Station 1. These openings are cut at this time to reduce the resistance of the strip to the drawing tension during the succeeding op-

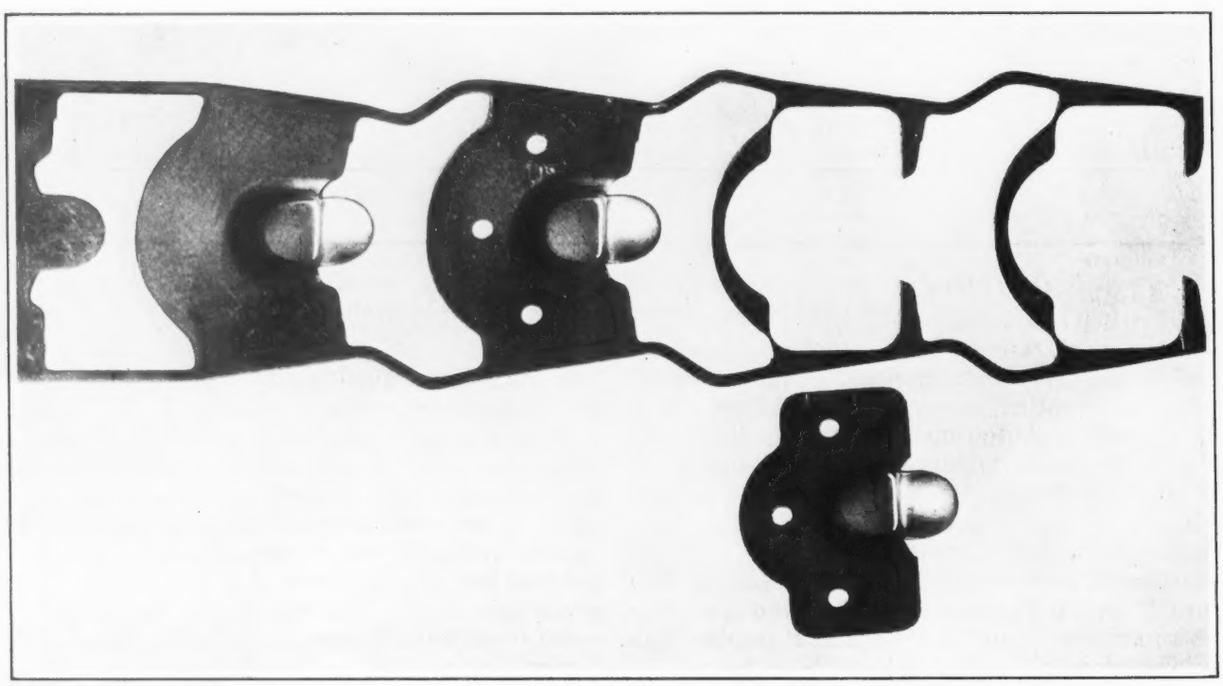


Fig. 2. Skeleton of the Strip Stock, Showing the Steps in Making the Partly Formed Blank in the Progressive Part of the Die

eration. At Station 2, the tongue is formed and the lug is partly drawn. The lug is not completely drawn at this station, because it was found impossible to obtain the sharp corners required without rupturing the work. These sharp corners are therefore produced at Station 3. In addition, the three holes are pierced at this time. At Stations 2 and 3, spring pads are provided for raising the strip to permit it to pass smoothly over the die during the feeding movement. At Station 4, the part is completely blanked from the strip. The skeleton of the strip, together with the part after it is blanked out, is shown in Fig. 2.

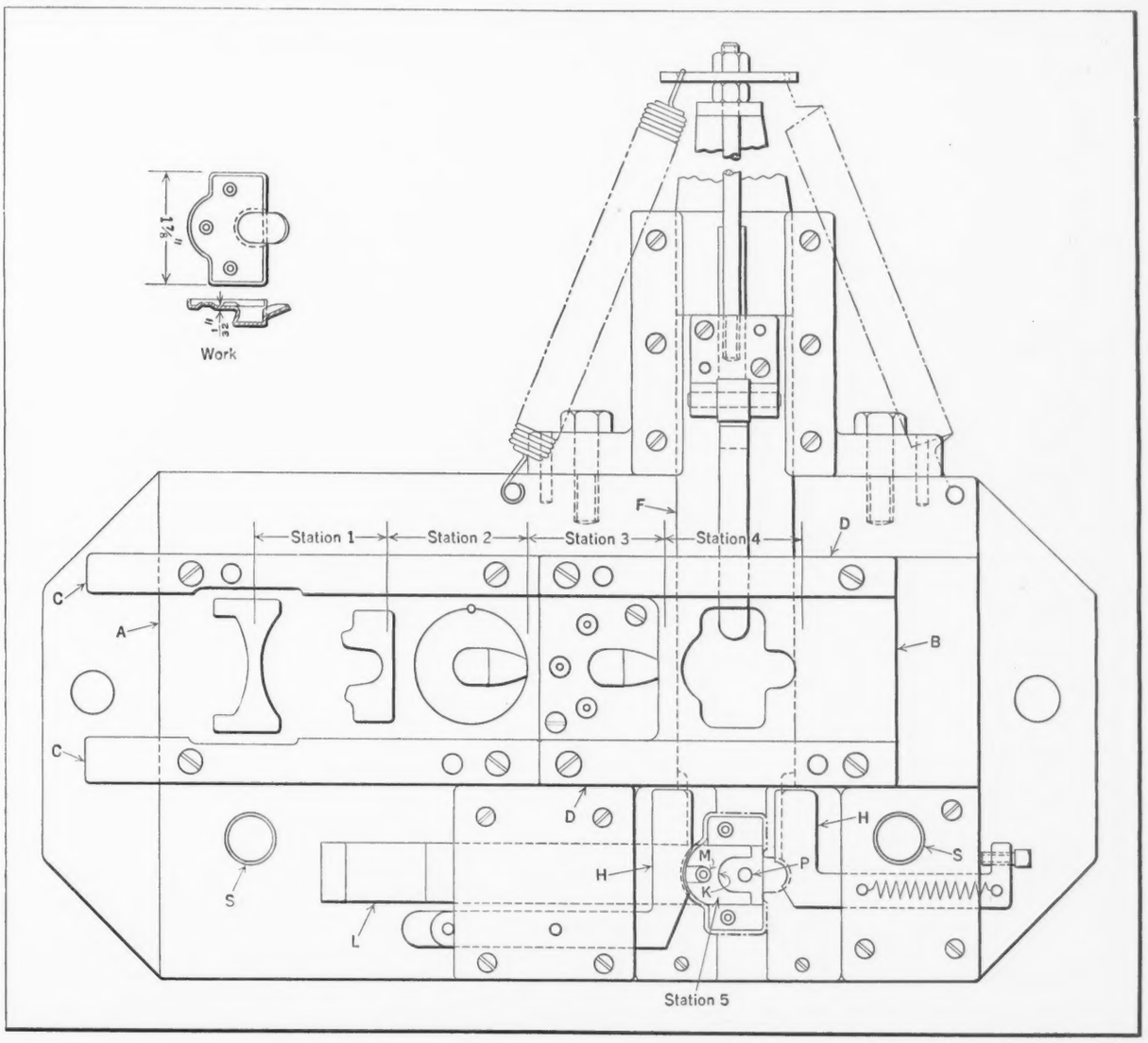


Fig. 3. Plan View of Die for Completing the Thin-walled Shell Shown in Fig. 1 in One Stroke of the Press

Transferring the Blank for the Final Operations

Owing to limitation of die space on the press, the progressive part of the die could not be carried farther, although the countersinking of the three holes could be done at another station before blanking the part. Therefore, after the blank has been cut, it is carried to Station 5 at the front of the die by means of a transfer slide *F*, where the final operations are performed. The action of this slide is clearly shown in Fig. 5. Cam *G* on the punch-block engages a roll in a bracket fastened to the slide.

The left-hand end of the slide is shaped to form a seat to receive the blank, and at the right-hand end are mounted two springs that keep the cam and the roll in engagement. With this arrangement, as the press ram descends, the blank is cut and pushed down through the die on the slide seat. As the ram ascends, the receding cam allows the slide to move toward the left with the blank. At the end of the upward stroke, the blank is in a position directly over the die at Station 5. To prevent the return of the blank with the slide as the ram again descends, spring fingers *H* are provided, which grip the blank and serve to align the blank at this station.

The blank is shown in position between these fingers in Fig. 6. As the ram descends, the blank is

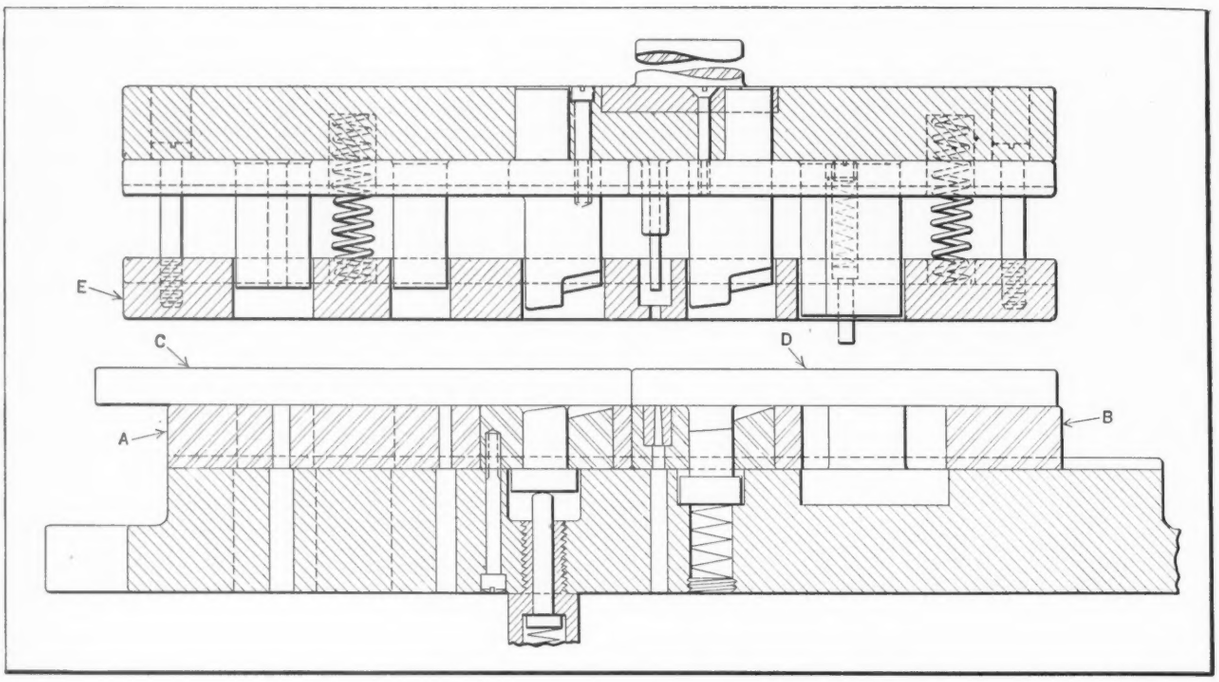


Fig. 4. Sectional View of the Die. Note the Combination Blank-holder and Stripper which Provides a Constant Pressure on the Strip

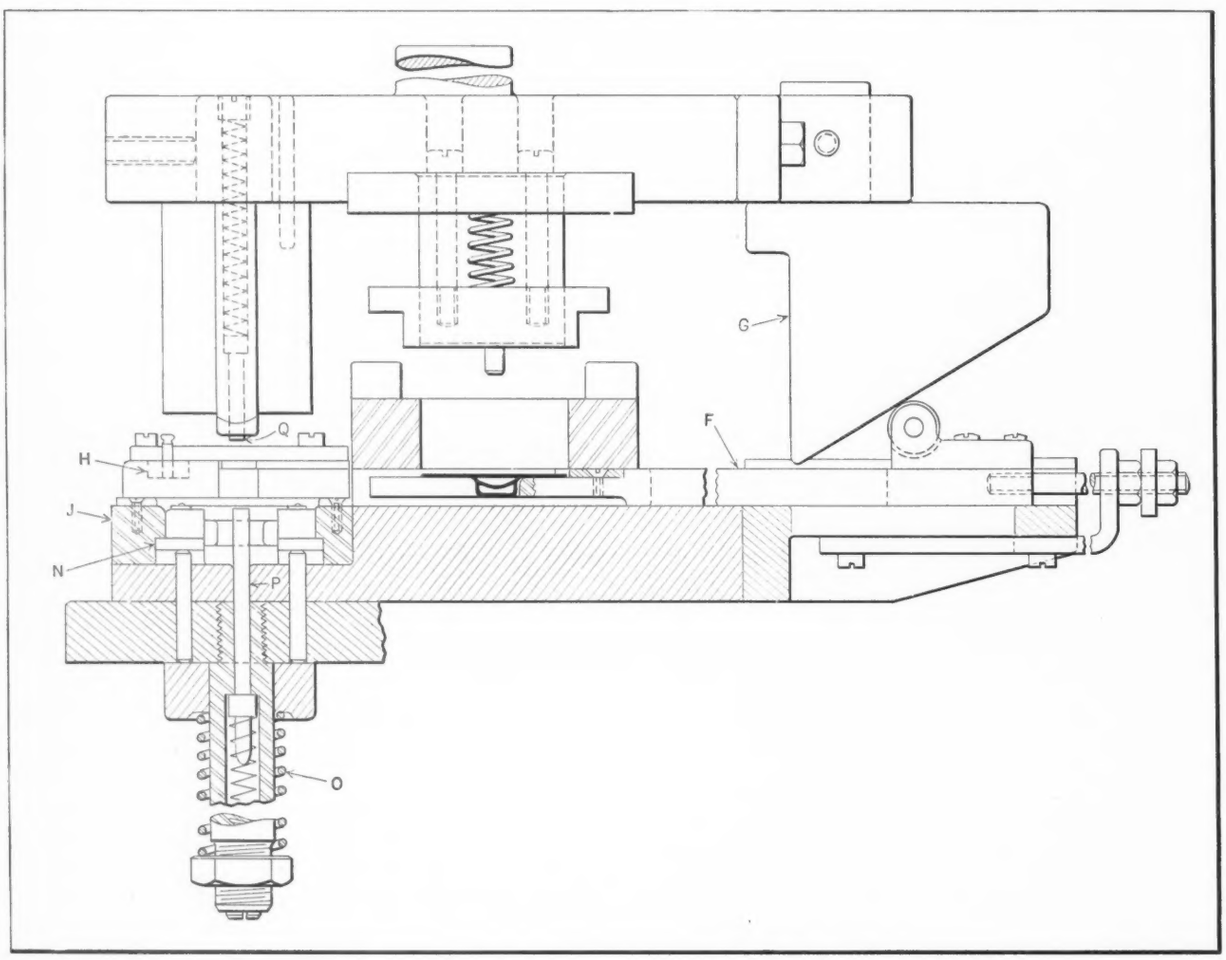


Fig. 5. View of Die Showing Cam-operated Slide for Transferring the Blank into Position for the Final Forming Operations

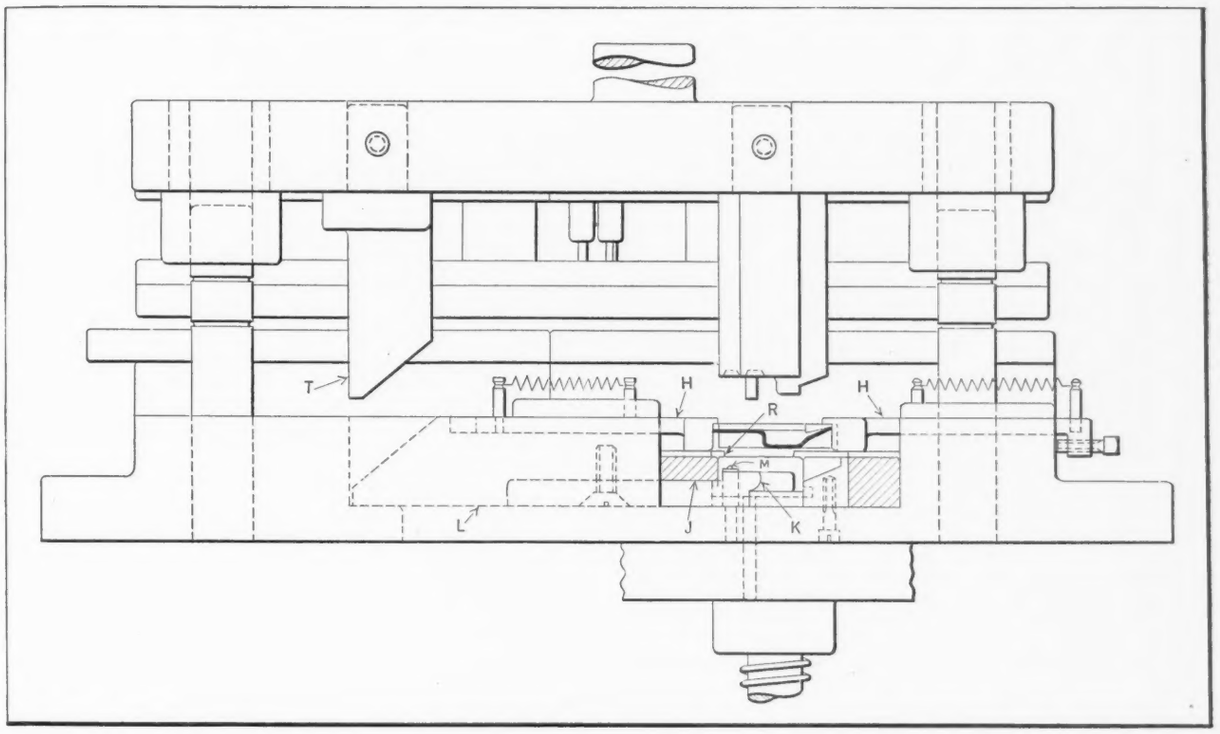


Fig. 6. View Showing the Cam-operated Punch Slide for Forming the Hook in the Lug of the Stamping. Note that the Countersinking and Flanging Die are Also Located at this Station

carried down into nest *R* and then into the die *J*, which forms the narrow flange. While passing into this die, however, the hooked portion of the work is formed and the holes countersunk. The hooking operation is effected by the punch *K*, secured to the slide *L*. This slide is operated by the cam *T*, which engages the beveled end of the slide.

All three countersinking punches *M* are set solidly in the bottom of the die. Thus, as the blank is forced by the forming punch past the top edge of the flanging die, punch *K* is gradually forced against the lug for the remainder of the stroke, at the end of which time the hook is completely formed. Just before the end of the stroke, however, the punches *M* enter and form the countersink in the holes.

Upon the upward stroke of the ram, the finished part is forced out of the die by the pad *N* (Fig. 5), operated by the spring buffer *O*, and is stripped from the forming punch by spring pin *Q*. Within the buffer is a spring plunger *P* which continues the upward vertical movement of the part until it is clear of the die. Thus, as the slide *F* moves toward the left, the front end of the slide will push the finished part off the die.

Compensating for the Unequal Spacing Resulting from Strip Distortion

It is of interest to note that all four stations in the progressive part of the die are equally spaced. Any distortion in the strip produced by the drawing and forming operations is compensated for by the stretching or bending of the narrow connecting strips. The drawing punch at Station 2, Fig. 3, is the first to enter the strip; hence, the strip will be drawn toward the right. To permit the strip to be drawn in this direction, provision was made for releasing the roll feed momentarily at the completion of the feed and during the operation of the drawing punches. Alignment of the die members is maintained by the two pillar posts *S*. As in other work of this type, the size and contour of the blank were determined by trial.

* * *

The first steam turbine generating unit to be operated commercially in the United States is now on exhibition at the Chicago Exposition in the Central Station Industry Exhibit. This is a De Laval geared steam turbine driving a direct-current generator that was actually used to supply current at the World's Fair in Chicago in 1893, and that is believed to be the first steam turbine generator unit placed in commercial service in the United States. Steam was expanded from 125 pounds gage pressure to atmospheric pressure through diverging or flaring nozzles which had been invented by De Laval in 1888 and which are now employed by practically all turbine builders. That the theory of such nozzles was far from obvious, however, is shown by the fact that when De Laval applied for a United States patent in 1889, he was met with the objection from the Patent Office that the idea was not workable, and it was only after the machine had been exhibited in actual operation at Chicago that the Office was convinced and the patent allowed.

EDITORIAL COMMENT

Getting Along Without Foreign Trade — the Latest Bright Idea

As a remedy for our industrial troubles, it is being urged by many that this country practically discontinue foreign trade and become almost completely self-sufficient. The advocates of this novel policy present a list of theoretical advantages which at first might seem to offer substantial opportunities for business improvement and steady employment. But, before accepting these ideas on their face value, let us examine the records of recent years and see what has actually taken place.

In 1929, our exports amounted to over $5,000,000,000; in 1932, they had shrunk to a little over $1,500,000,000—a net loss of about $3,500,000,000. During the same period, the import figures showed a loss of about $3,000,000,000, from a total of around $4,500,000,000 in 1929.

According to the theory of the isolationist, the shutting out of $3,000,000,000 worth of imports by this country should have furnished that much additional market for domestic manufacturers. The contrary, however, proved to be the case. The tremendous reduction in our foreign trade, instead of stimulating domestic buying, further depressed the market for products made in this country. Instead of increasing employment, it caused a vast amount of unemployment, for when our exported products were reduced to the extent of $3,500,000,000, those engaged in making these products found themselves out of a job.

This is an excellent illustration of what the effect would be on industry and employment if we undertook to wholly exclude foreign goods and attempted to get along without international trade.

It Might be Wise to Take this with a Grain of Salt

"The nations of the world have overstocked themselves with machinery and manufacturing plants far in excess of the wants of production. The full supply of economic tools to meet the wants of nearly all branches of commerce and industry is the most important factor in the present industrial depression. Though the discovery of new methods and processes of manufacture undoubtedly will continue, and this will act as an ameliorating influence, it will not leave room for marked extension, such as has been witnessed during the last fifty years, or afford employment for the vast amount of capital which has been created during that period. The day of large profits probably is past."

No, this was not originally written for publication in this number of MACHINERY; it is an abstract from a report of the United States Commissioner of Labor in 1886 (!) as quoted in *Tool Tips*, published by the Ex-Cell-O Aircraft & Tool Corporation. It merely proves that history repeats itself, and that our present problems are not new. It also proves that there is nothing new in the idea that industry has come permanently to a standstill. There have always been those who have been ready to jump at that conclusion.

The Part Played by Drawing in Technical Education

"Drawings are the language of the engineer," said a professor in one of our leading engineering schools recently; "the most fundamental of all subjects taught in engineering schools is drawing, and therefore particular attention should be paid to teaching the student to read and interpret drawings. Yet many schools ignore this subject to a surprising degree, letting the students acquire a mere surface knowledge of the subject."

Assuming that this statement is correct, it presents a serious problem to those in charge of engineering education. The young graduate engineer should certainly know the language of his profession and should be able to make, read, and interpret drawings without the slightest difficulty. This is as essential to progress in his profession as the ability to read and write is to the continued study of a child.

There have been complaints that engineering schools devote so much time to advanced subjects that some of the more elementary or fundamental subjects are neglected; yet, it is these fundamentals that are absolutely necessary in order to establish a firm basis for an engineering education.

It is a fairly common criticism of modern education in general—not engineering education alone—that the student obtains a smattering of many things, but knows nothing thoroughly. In engineering education, there is a tendency to cover many subjects in a comparatively brief time. Perhaps it would be better if the spread were not so great, and fewer subjects were taught more thoroughly.

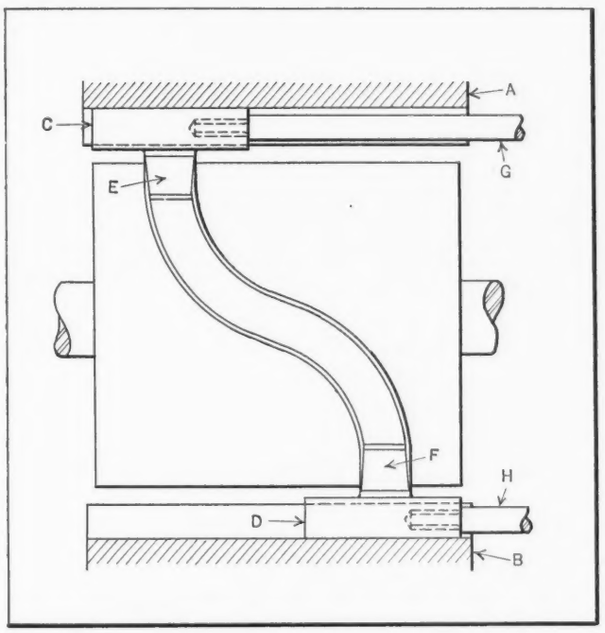
Ingenious Mechanical Movements

Mechanisms Selected by Experienced Machine Designers as Typical Examples Applicable in the Construction of Automatic Machines and Other Devices

Operating Two Slides in Opposite Directions with One Single-Groove Cam

By J. E. FENNO

In designing mechanisms, the writer has found that there is usually more than one way of "skinning a cat." For example, in redesigning a tapping machine to be used for tapping opposite sides of a part simultaneously, two tapping heads were required to travel in opposite directions. This movement, as first suggested, was to be obtained by means of individual cams. After some study, however, a simpler method was devised for transmitting movement to both heads, a single cylindrical cam being used, as indicated in the accompanying diagram.



Cylindrical Cam with One Groove which Serves to Move Two Slides in Opposite Directions

The diagram is so clear that it hardly requires a description. There are numerous cases to which this idea may be applied, with a great reduction in construction and upkeep cost. As indicated, one cam groove serves both heads (not shown). In stationary guides *A* and *B*, on opposite sides of the cam, are slides *C* and *D*. These slides carry the rolls *E* and *F*, both of which engage the same cam groove. The slides are connected to their respective heads by the tie-rods *G* and *H* through which the required movement is transmitted.

Mechanism for Converting Rotary into Reciprocating Motion

By RALPH A. GLEASON
Consulting Mechanical Engineer, Baltimore, Md.

The principle of the hypocycloid, as illustrated in Fig. 1, has been applied very effectively in the mechanism shown in Figs. 2 to 4. This mechanism is designed to convert rotary motion into reciprocating motion. The hypocycloid *SS*, Fig. 1, is generated by the point *P* in the generating circle *G* as it rolls on the inside of the fundamental circle *F*. The hypocycloid thus generated by point *P* is a straight line when the diameter of the generating circle *G* equals the radius of the fundamental circle *F*. A mechanism designed on this principle will give a long stroke with a minimum number of small strong parts arranged in the most compact form.

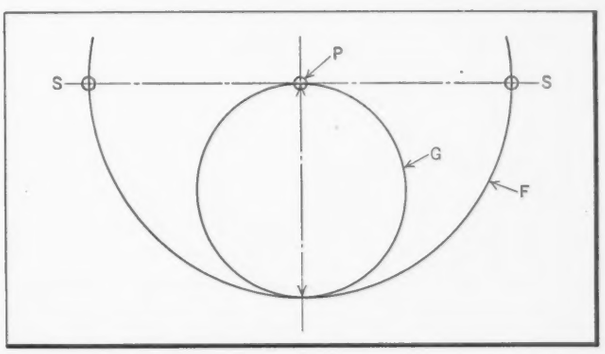


Fig. 1. Diagram Illustrating Application of Hypocycloid to Reciprocating Mechanism

In the principal application to be described, the fundamental circle *F* becomes the pitch line of a fixed internal gear, and the generating circle *G* becomes the pitch line of a pinion that rolls around on the inside of the internal gear. The point *P*,

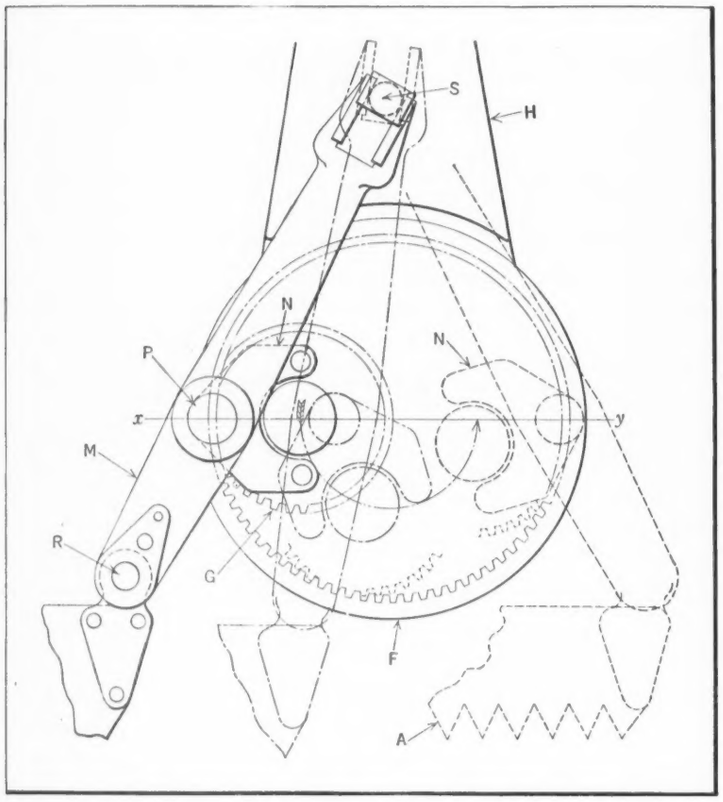


Fig. 2. Saw-reciprocating Mechanism Based on Hypocycloid Principle

which is at all times located at the exact intersection of the pitch line *G* with the center line *SS* of the internal gear, becomes the stroke pin. As the pinion rolls, this pin moves back and forth on a straight line from *S* to *S*, which is the equivalent of the pitch diameter of the internal gear. The arrangement shown in Figs. 2 to 4 forms the operating mechanism of a saw for sawing off piling. The saw *A*, Fig. 2, has a stroke of 12 inches, and the internal gear *F* has a pitch diameter of 8 inches. The complete machine is made of Duralumin, and, without the motor, weighs 43 pounds.

In Fig. 3, the specific problem was to design and build a one-man portable machine for sawing off piles *C* at low tide. These piles were 18 inches in diameter and were spaced 30 inches apart, center to center. Plan and elevation views show the assembled machine attached to a 2- by 12- by 48-inch timber *E*, supported on pile *D*, which was hand-sawed. The saw and the guide arms are shown in three positions by dotted lines to indicate how the reciprocating members clear the adjacent piles. Fig. 2 shows the reciprocating mechanism to a somewhat larger scale than Fig. 3. Sectional elevation and inverted plan views of the power-driven parts are shown in Fig. 4.

The direction of the stroke is determined and fixed when assembling the stroke pin *P* and the pinion *G* in the internal fixed gear *F*. In Figs. 2 and 4, the line *x–y* is at right angles to the extension arm *H* of the frame *J*. The internal gear *F* is made as a separate piece only for convenience in cutting the teeth and to provide a bottom bearing for the driving pinion *K*, Fig. 4. The outside end *L* of pinion *K* was squared and connected to an air motor which runs at a speed of 800 revolutions per minute. This gives the saw about 72 strokes per minute.

The stroke pin *P* and its bracket *N*, riveted to the rolling pinion *G*, are shown in three positions in Fig. 2 to illustrate how the pin *P* follows line *x–y*, carrying with it the forked link *M* which has pin *R* pivoted on its short end. The long end of link *M* is forked around the squared fulcrum pin *S*, Fig. 4, which swivels in the hub *Q* of the extension arm *H*. The shoulder-stud *T*, Fig. 3, is supported in frame *V* and fixed in position by pin *U*. A vise handle *W* in frame *J* permits the operator to swing the whole assembly on stud *T* to adjust and feed the saw.

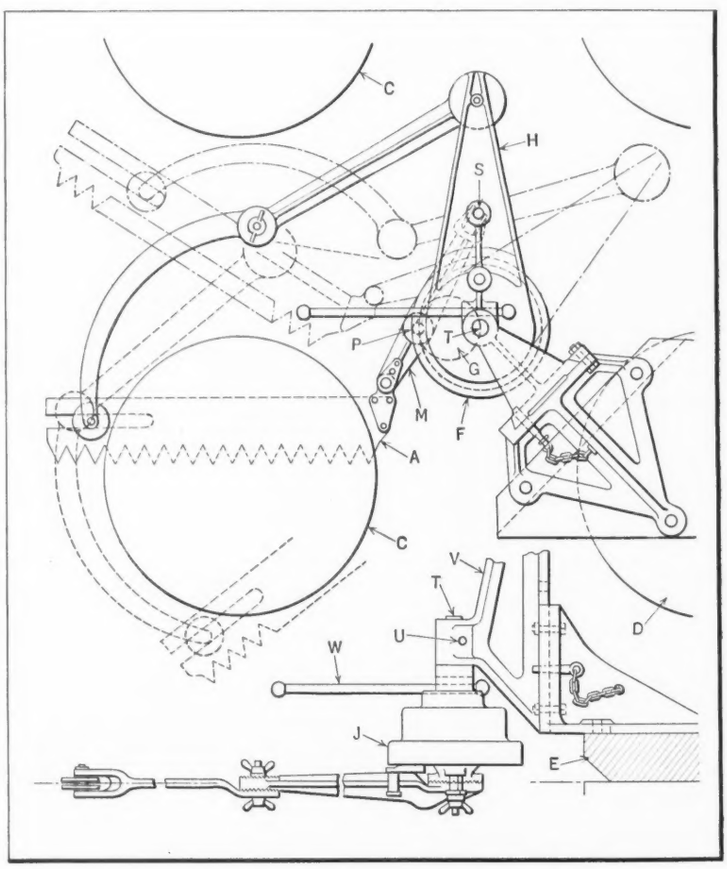


Fig. 3. Assembly of Saw Operated by Mechanism Shown in Fig. 2. Dotted Lines Show Starting and Finishing Positions of Saw in Cutting off Closely Spaced Piles

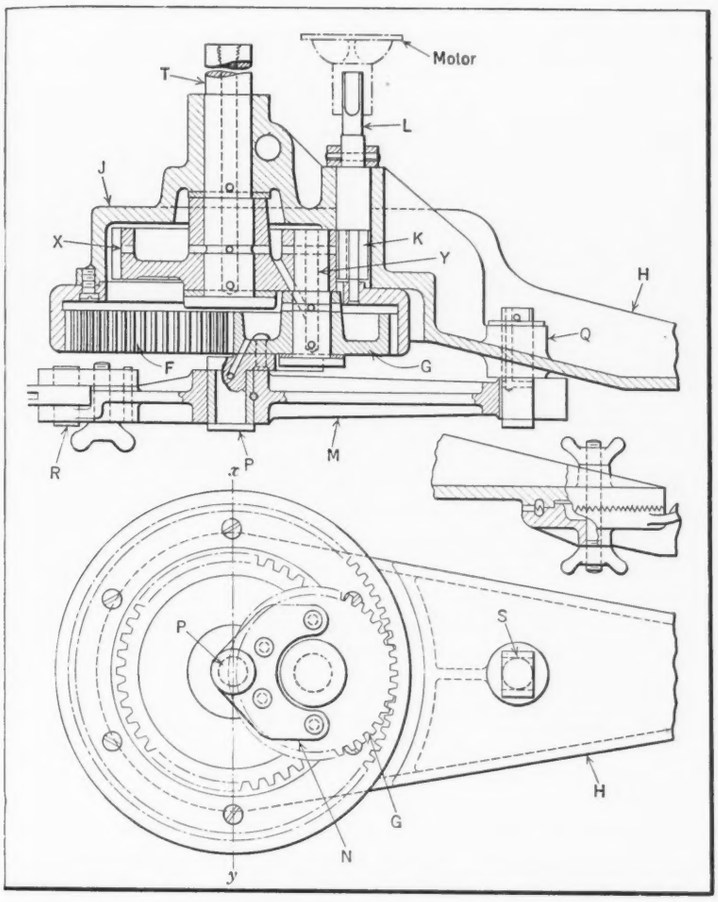


Fig. 4. Cross-section and Plan Views of Saw-reciprocating Mechanism

Referring to Fig. 4, the motor-driven gear X is a running fit on stud T, the head of which serves as a support for the gear. The crankpin Y, fixed in gear X, has pinion G mounted on its head. Suitable thrust washers are provided for both gears X and G. The stroke-pin bracket N is riveted to pinion G, with the center line of the pin P located on the pinion pitch line. The pin P turns freely in a bushing made in halves to facilitate assembling. The halves of this bearing are pinned securely to the forked link M. Holes and grooves for providing ample lubrication from one grease cup screwed into the top of stud T are shown in Fig. 4.

* * *

Dictionary of Electrical Terms

A proposed dictionary of electrical engineering terms, representing the results of over three years' work by a committee of 120 scientists and engineers, has just been published for review and criticism prior to being submitted to the American Standards Association for adoption as an American standard. The report, prepared under the direction of the American Institute of Electrical Engineers, 29 W. 39th St., New York City, covers 208 pages and lists over 3400 definitions pertaining to electrical terms.

Flying Airplanes Automatically

An automatic mechanical pilot that actually flys an airplane has been installed on one of the new "three-mile-a-minute" Boeing transport planes of the United Air Lines. This device is encased in a metal box about a foot square. The entire installation weighs only about 30 pounds. It is termed the "airobot," and while it is not intended to dispense with a human pilot, it will relieve him of the active manipulation of the controls, thus allowing him more time to study weather conditions. Regular pilots take off and land the planes in the usual way.

The mechanism contains two gyroscopes, one operating on a vertical axis and the other on a horizontal axis. These gyros control a mechanism that actuates the controls. By regulating the dials, the pilot can adjust the "airobot" so that after the plane takes off, it climbs to any given altitude and straightens out on a level flight course. Practically every manoeuver that the plane may be caused to perform in flight by manual action of the controls can be duplicated by the automatically controlled plane. The device controls the plane so effectively that the pilots can even leave the control cockpit without fear that the plane will deviate from level flight over a specified route.

* * *

Hoist Manufacturers Organize Practice Code Committee

The Electric Hoist Manufacturers' Association, with headquarters at 165 Broadway, New York City, at its last meeting appointed a committee consisting of F. A. Hatch, president, Shepard Niles Crane & Hoist Corporation, Montour Falls, N. Y.; F. F. Seaman, general manager, Hoist and Crane Division of Robbins & Myers Sales, Inc., Springfield, Ohio; and J. G. Worker, general sales manager, American Engineering Co., Philadelphia, Pa., to draft a Code of Practices for the electric hoist manufacturing industry. This code will be presented to the membership of the Association for adoption at an early meeting, after which it will be submitted to the Administration at Washington for the President's approval.

* * *

In a paper read before the last annual meeting of the Society of Automotive Engineers, Herbert Chase emphasized the fact that automobile bodies are now so low as to be both uncomfortable and unsafe. He stated as his belief that, in the future, automobiles better proportioned for their purpose can also be made better looking.

Hones for Producing Smooth and Accurate Bores

Principles of Design of Hones that Have Come into General Use for Finishing Engine Cylinders and Other Accurate Bores

THE higher the speed of machinery or engines, the more important become the finish and accuracy of the moving parts. Sometimes, as in the case of locomotives, a high degree of smoothness of the working surfaces of moving parts is even more essential than a close fit. Whether a part should be bored, reamed, broached, ground, or honed, therefore, depends upon the use to which it will be put.

Honing has been universally adopted in the automobile field during the last ten years for finishing the bores of cylinder blocks, because this method gives a mirror-like polish to the cylinder walls and, at the same time, finishes them to size and parallel within close limits of accuracy. This article will briefly describe some of the honing tools in common use for finishing bores, both large and small.

In the early type of hone, shown in the two left-hand views of Fig. 3, three abrasive blocks attached to shoes were adjustable outwardly by drawing together two opposed vertical cones, which were free to float. In this type of hone, the abrasive stones adjusted themselves to touch the bore all over. If the cones were pointed in the same direction, as indicated in the right-hand view of Fig. 3, automatic adjustment to the bore would not take place.

It might be thought offhand that floating cones

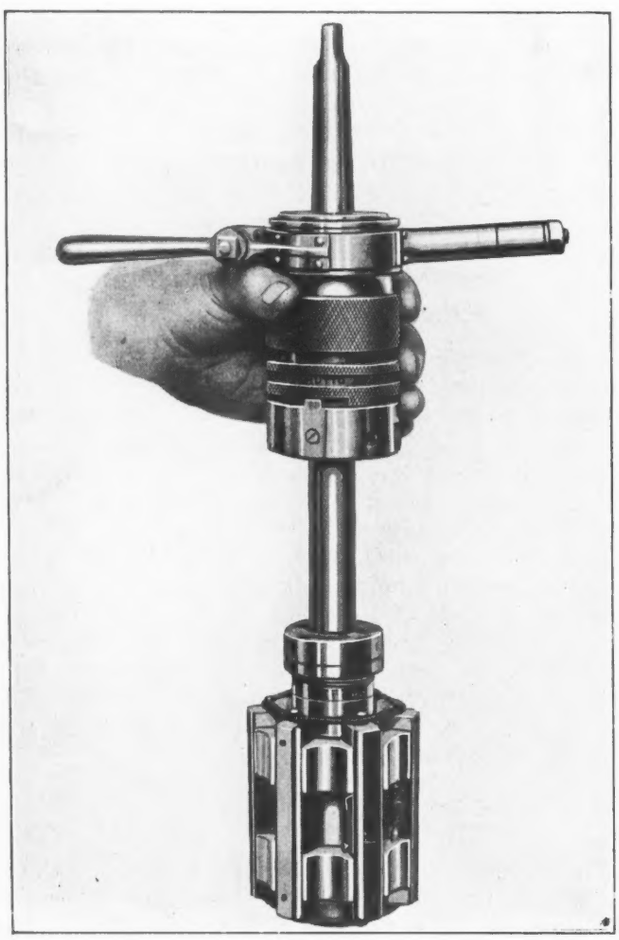


Fig. 1. A Hone that Employs the Principle of Expansion Illustrated by the Two Left-hand Diagrams in Fig. 3

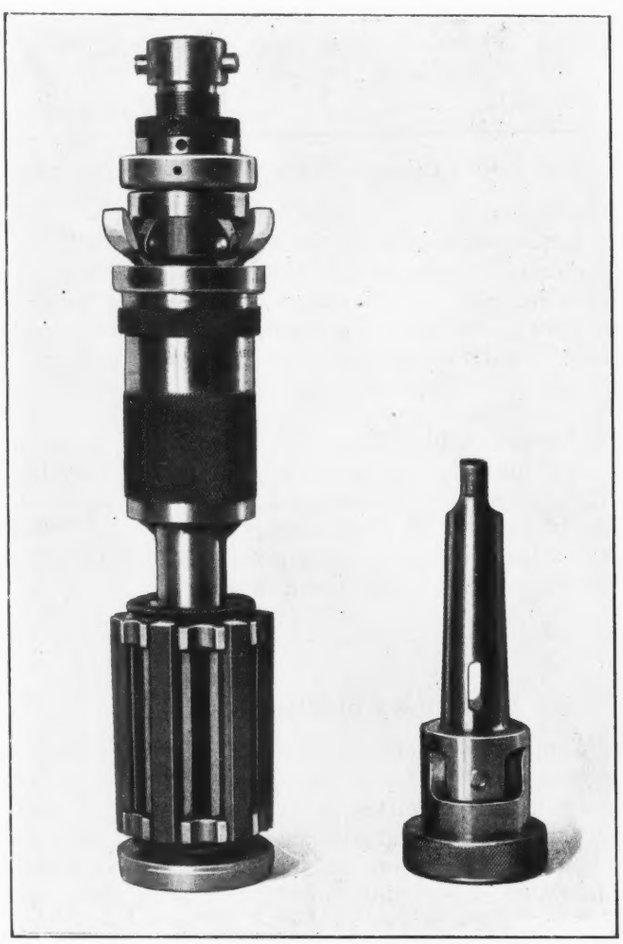


Fig. 2. Finger Type of Hone that Expands Automatically when Entered into a Bore and Contracts when Removed

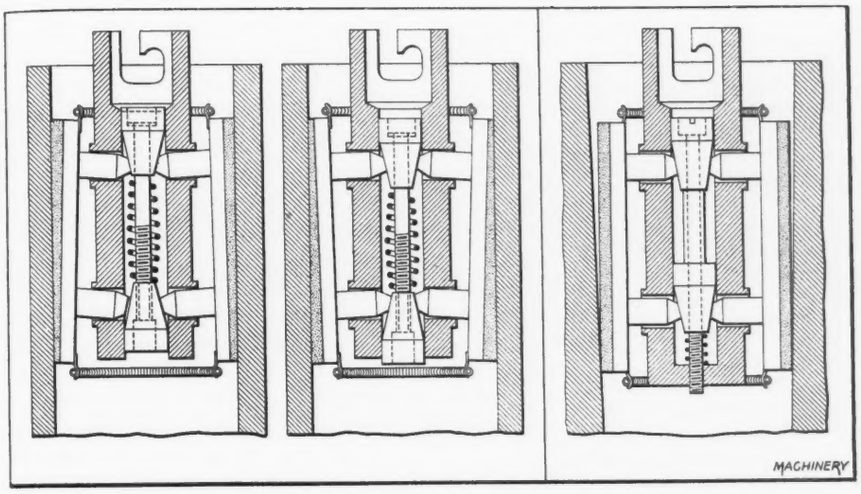


Fig. 3. Diagrams that Show How Opposed Cones in One Type of Hone will Eliminate Taper in Bores and Why Cones Pointing in the Same Direction do not Eliminate Taper

would allow a tapered bore to remain tapered during the honing operation, but this is not so, because the diameter across the outside of the stones at the center of their length is constant, irrespective of the angle to which the stones may be inclined. The center portions of the stones remove the metal at a narrow point in the bore as the hone is reciprocated, instead of this work being done by the ends of the stones only. The latter condition would lead to very rapid wear of the ends, and consequently, it is important that the stones be in contact with the bore along their entire length.

The flood of kerosene used to wash away the abrasive loosened from the stones and the stock removed from the cylinder walls also cools the work, and thus prevents expansion and distortion.

The hones shown in Fig. 3 were found unsuitable for everyday use, owing to their fragility. The pins that transmit the pressure from the adjusting cones to the abrasive stones, being weak, broke frequently. Lack of a definite means of adjusting the stones necessitated frequent measuring of the bores during honing to see whether they had been finished to size or not. This made the use of hones slow and expensive.

Hutto Hones for Various Applications

In order that the abrasive stones of the L-type Hutto hone, shown in Fig. 1, shall contact with the bore along their entire length, irrespective of the shape of the bore, they are adjusted radially outward by two opposed cones similar to those described in connection with the two left-hand diagrams in Fig. 3. This hone is designed for use on small automobile cylinders, bushings, etc. It is made in four sizes that cover all bores from 2 3/16 to 6 1/8 inches in diameter, the stone lengths ranging from 2 1/2 to 6 inches. Power is delivered to the hone through a universal joint, which permits the hone to float freely in the bore and align itself automatically.

This hone is expanded during the operation by the operator gripping a brake handle which retards the motion of an adjusting sleeve. This action, through gears, turns a screw which draws the two opposed cones together, thus forcing the abrasive stones outward. A micrometer stop permits of setting the hone to the predetermined size of bore and prevents it from expanding beyond that point. In this way, it is impossible to finish a cylinder bore beyond the size to which the hone has been adjusted. Abrasive stones for this type of hone are fixed in adapters or shoes made from the solid.

For use in multiple operations, as in automobile plants, the Hutto Engineering Co., Inc., Detroit, Mich., has developed the hone illustrated in Fig. 4, which has an automatic drive-head. The important feature of this drive-head is that it automatically expands when it is inserted in the work and contracts when it is withdrawn. This automatic action is accomplished by three fingers which operate in a guide bushing that moves them radially as the hone is entered into or removed from a bore. Much time is saved by eliminating the necessity of doing this manually.

One major setting of the micrometer adjustment is all that is required for honing all bores of the same diameter to equal limits. The only additional adjustment required is

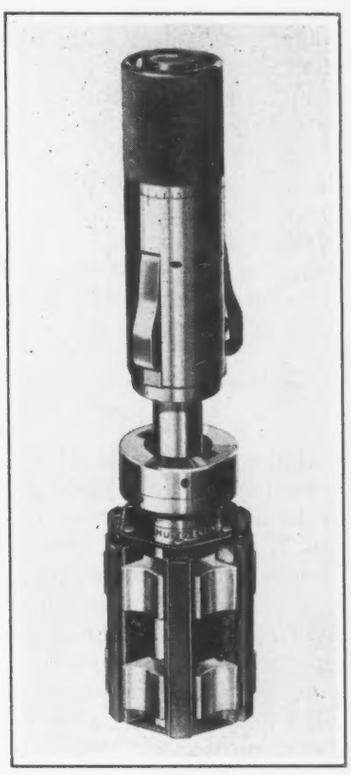


Fig. 4. Another Hone that Expands and Contracts Automatically

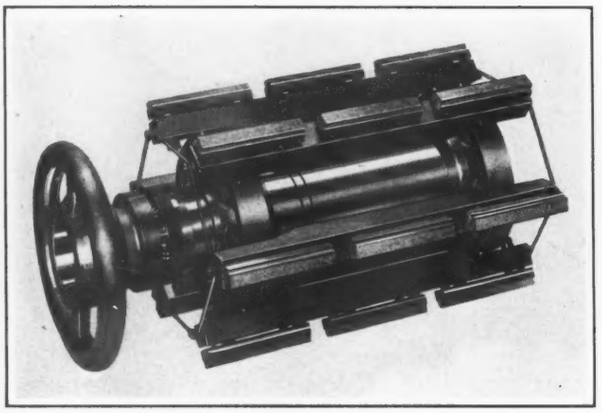


Fig. 5. This Type of Hone is Intended for Large Work, such as Cylinders of Diesel Engines

occasionally to compensate for wear of the abrasive stones. Anti-friction bearings in the adjusting mechanism assure ease in making new settings.

A large hone made by the same concern for honing the cylinders of Diesel engines is illustrated in Fig. 5. The two end flanges that support the master stone-holders are removable. All these holders have a long pin at each end that passes through the corresponding flange and bears on one of the two opposed cones. When the cones are drawn together, they act upon these pins and force the master stone-holders outward. Springs which pass around the stone-holders in a polygonal outline prevent the holders from flying outward, due to centrifugal force, at high speeds and into portholes, keyways, or other recesses in the bore being finished.

Adjustment of a hone of this type from one size to another can be made by inserting washers between the abrasive stones and the master stone-holders or by providing flanges of different diameters.

Fig. 6 shows a tool consisting of two hones connected by a hollow shaft. This tool was designed for honing locomotive steam valves, air pumps, or the bearings of such parts as lathe headstocks. The top view shows the tool partly assembled in an air pump, while the bottom view shows it completely assembled. The advantage of using a double-ended hone for such work is that the two bores are finished accurately in line with each other.

A Hone Expanded by Cones Tapered in the Same Direction

Hones made by the Hall Mfg. Co., Toledo, Ohio, are expanded by adjusting cones 10 and 11, Fig. 7, in the direction of arrow *L*. This action moves pins 5, 6, 7, and 8 and the stone-carriers radially. If any abrasive stone should wear unevenly, as indicated by the top stone in the illustration, the pressure on end *C* would cause the stone-carrier to move in the direction indicated by arrow *K*. This would make end *C* of the stone-holder slide down on end 2 of pin 8 and make end *D* ride up end 1 of pin 7 until the stone was in contact with the bore along its whole length. Should one stone be shallower all along its length than the other stones, it would not be in contact with the bore until the other stones had been worn down.

The Hall hone shown in Fig. 8 is provided with a quick-expanding device and a micrometer adjustment which enables the hone to be set for finishing a bore to a definite diameter. Hall hones can be arranged to expand automatically. The company also makes hones as small as 1/2 inch for general machine shop use. These hones will remove from 0.0005 to 0.003 inch of stock from holes machined under size or holes that have shrunk in hardening operations.

A Hone that is Expanded by a Bushing

The hone illustrated in Fig. 2, which is made by the Micromatic Hone Corporation, Detroit, Mich., for mass production work, such as automobile cylinders, is provided with fingers which press against the inside wall of a guide bushing located above the work. As the hone enters the cylinder bore, the ends of these fingers *B*, Fig. 9, force collar *C*, the lower ball thrust bearing *A*, and feed-spring retainer *E* downward. This results in compressing the feed-spring *D*, which will then expand the hone outward until the spring has expanded so that it completely fills the retainer.

The hone is initially adjusted for removing a predetermined amount of metal. This is done by turning collar *C* to compress spring *D*. With this design, the hone cannot remove more material from the

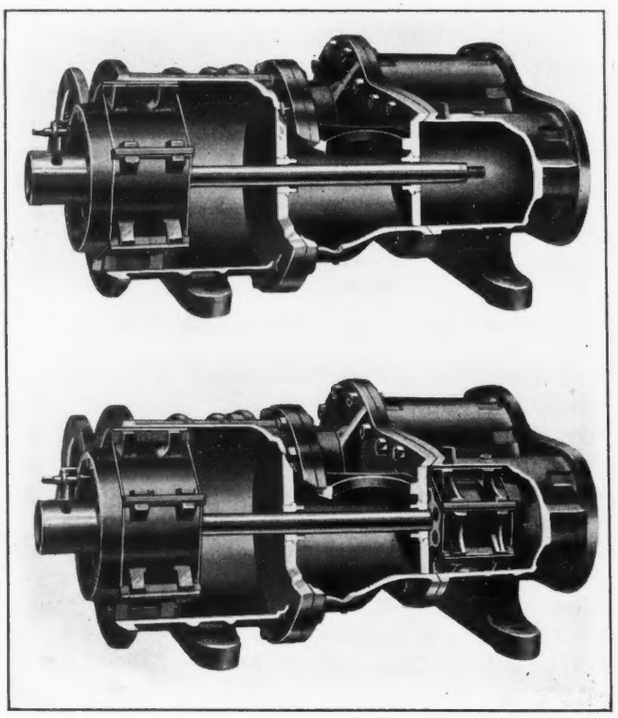


Fig. 6. Parts with Two Cylinders in Line with Each Other can be Simultaneously Honed by Employing Two Hones Connected by a Shaft

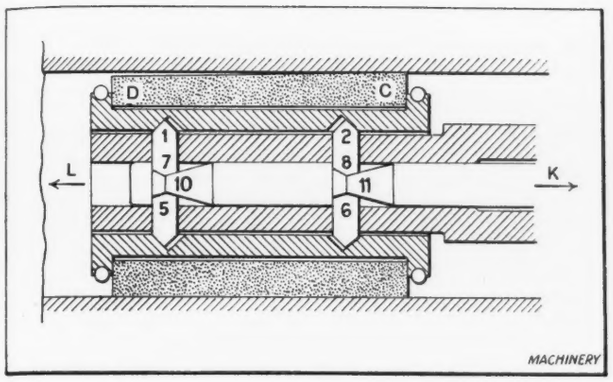


Fig. 7. The Principle of Stone Compensation Employed in Hones Made by the Hall Mfg. Co.

bore than is allowed for by the initial compression given to the spring.

Ball bearings *A* prevent fingers *B* from being turned in the guide bushing as the hone rotates. If the fingers did turn, they and the bushing would wear rapidly. The bushing should have a hardness of not less than 85 Scleroscope and should be 0.020 inch larger in diameter than the cylinder bore. The inner corners at the top and bottom of the bushings should be rounded slightly. The practice is to assemble the bushing so that its bottom edge is nearly flush with the bushing plate, about 1 inch above the top of the bore. Then the hone is automatically collapsed just before it is withdrawn from the bore.

In using this hone, the stroke is so adjusted that at the beginning of the stroke, the abrasive stones project about one-quarter of their length above the cylinder bore, and at the end of the stroke, about one-third of their length below the cylinder bore. Taper in bores can be eliminated by varying these projection distances.

The finger type of hone just described requires a certain amount of room between the cylinder bores to accommodate the guide bushings, if a multiple-spindle machine is used. Consequently, when the bores are close together or when long tubes are being honed, so that the body and head of the hone must pass into the tubes, another type of hone is necessary.

This requirement has been met by the Micromatic ratchet type hone shown in Fig. 10 and at the left in Fig. 12. Collar *B* can be slid upward to allow the nut on which it rides to be turned around for adjusting the stones radially to the desired size of bore. Adjusting nut *F* must then be turned one graduation to the right for every 0.0005 inch of stock to be removed. The hone is next expanded, after collar *B* has been allowed to fall, by adjusting collar *A* one-quarter turn to the left. Feed pressure is applied by spring *D* in a manner similar to that used in the finger type hone. The particular hone shown at the left in Fig. 12 is designed for honing Diesel engine cylinders.

Since the hone illustrated in Fig. 11 and at the right in Fig. 12 is considerably smaller than the other Micromatic hones described, it will be appreciated that the spring-loaded plunger adjustment in collar *B* is sufficient to prevent the collar from turning due to vibration. With this construction, the hone can be adjusted for slight differences in bore diameters more quickly than the other types of hones. It also permits the use of the same collar for adjusting for different bore diameters and for removing a definite amount of stock.

Non-abrasive wiper guides *J* centralize and guide the hone while it is being inserted in a bore or removed. They prevent the stones from scratching the bore along its length during the removal of the hone, this feature being particularly advantageous when the hone is used horizontally.

Maintaining the Abrasive Stones

The abrasive stones in Micromatic hones are mounted in inexpensive stampings, so that both the stone and its container can be thrown away when the stone is worn down, and replaced at low cost.

The manufacturer of Hutto hones supplies a suit-

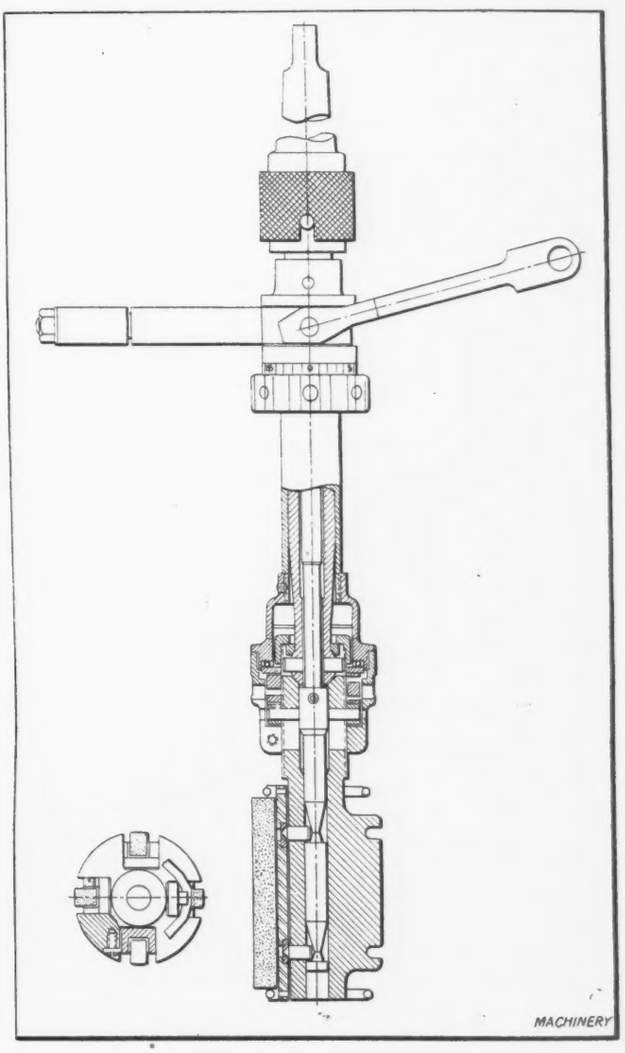


Fig. 8. A Brake Type Hone Equipped with a Micrometer Stop to Insure the Removal of a Definite Amount of Stock from a Bore

able fixture for babbitting new stones in the holders as the old ones become worn. Both the abrasive stone and the stone-holder are heated previous to babbitting to prevent cold shuts in the babbitt. After the stone and its holder have been correctly positioned, the fixture is closed preparatory to pouring babbitt metal through a funnel.

If an abrasive stone is in contact with the bore that it is to finish for the whole width of its face, it will tend to glaze rather than cut unless abnormal pressure is applied. For this reason, the stones of Hutto hones are generally arranged off center, as shown in the upper left-hand view in Fig. 13. The front edge is then in sharp contact with the bore and cuts efficiently. After a certain amount of use, the stones will be worn until they have a full contact, as shown in the upper right-hand view, when they will not remove metal as efficiently as before.

The stones are then turned end for end to bring a fresh cutting edge into use with plenty of clearance, as shown in the lower left-hand diagram. After awhile, the stones will become worn until they contact across about two-thirds of their width, as shown in the lower right-hand diagram, there still being about one-third clearance at *C*. If the stones are again reversed, a fresh edge will come into use, and if this reversal is made every time that the stones make two-thirds contact until the stone is worn out, efficient cutting action will be maintained, and the life of the stones prolonged.

* * *

Welding in an Automobile Plant

Some idea of the important part welding plays in the manufacture of automobiles is indicated by the following figures given by J. J. Fiechter at a recent meeting of the International Acetylene Association. An automobile plant that normally consumes between 25,000 and 30,000 tons of sheet steel a year, ranging in thickness from 0.025 to 0.078 inch, produces approximately 7,500,000 stampings or parts from this material. From 95 to 97 per cent of these parts are joined by welding. Between forty and fifty acetylene welders, twenty to twenty-five arc welders, and eighty to one hundred spot welders are employed for this work.

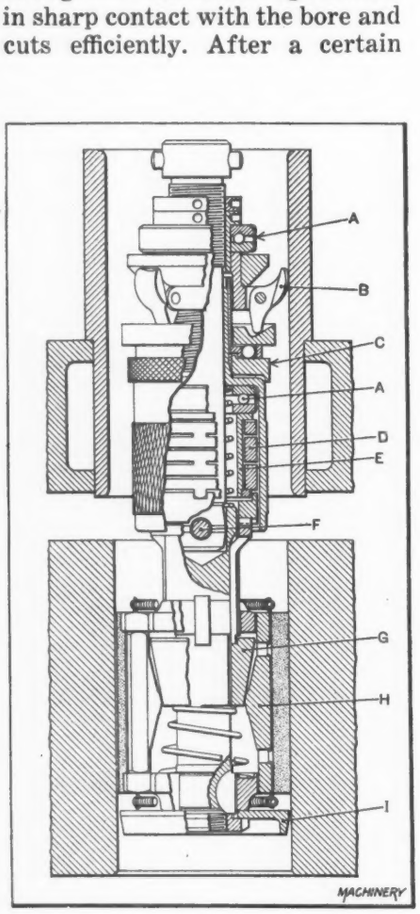


Fig. 9. Construction of the Automatically Expanded Finger Type Hone Illustrated in Fig. 2

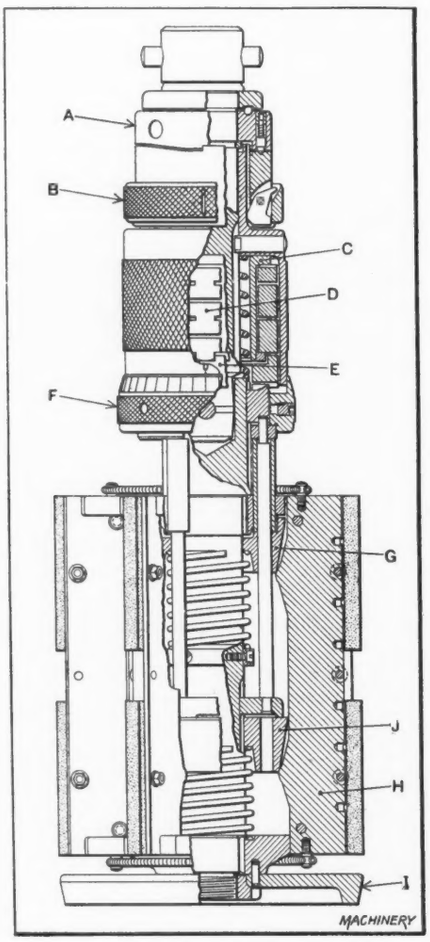


Fig. 10. Ratchet Type Hone that Does not Require Bushings to Expand Abrasive Stones

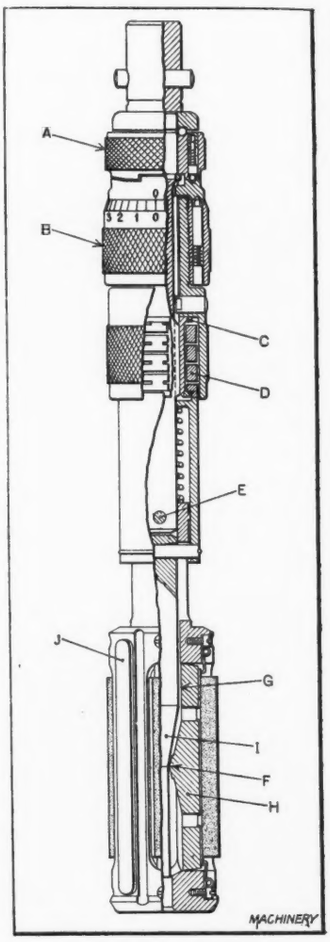


Fig. 11. Detailed Construction of the Hone Seen at the Right in Fig. 12

Wrenches are Made Long Enough

By W. F. SCHAPHORST

Several times the writer has seen a "kink" in print telling how to make a wrench longer by "slipping a gas pipe over it." It is a very simple procedure and it may look good to some, but ordinarily, increasing the length of a wrench in order to make nuts tighter is not advisable.

It has doubtless been observed that wrenches for small nuts are invariably short; for medium nuts, medium in length; and for large nuts, long. The manufacturers seem to have some reason for making wrenches certain lengths. The pitch of the thread, the cross-sectional area of the bolt at the bottom of the threads, and the strength of the man who does the tightening are all considered. Therefore, in making a wrench "twice as long," the tension is increased on the bolts to twice the amount, while the pulling force on the wrench remains the same.

By increasing the length of a wrench, the writer frequently has tightened nuts until the stretching of the metal in the bolts could be felt, or has actually stretched the bolts until they broke in two. It is poor practice to increase the length of wrenches, as the elastic limit of the bolt should never be exceeded. If anyone feels like making a wrench longer for unscrewing a nut—all right. But don't make it longer for tightening.

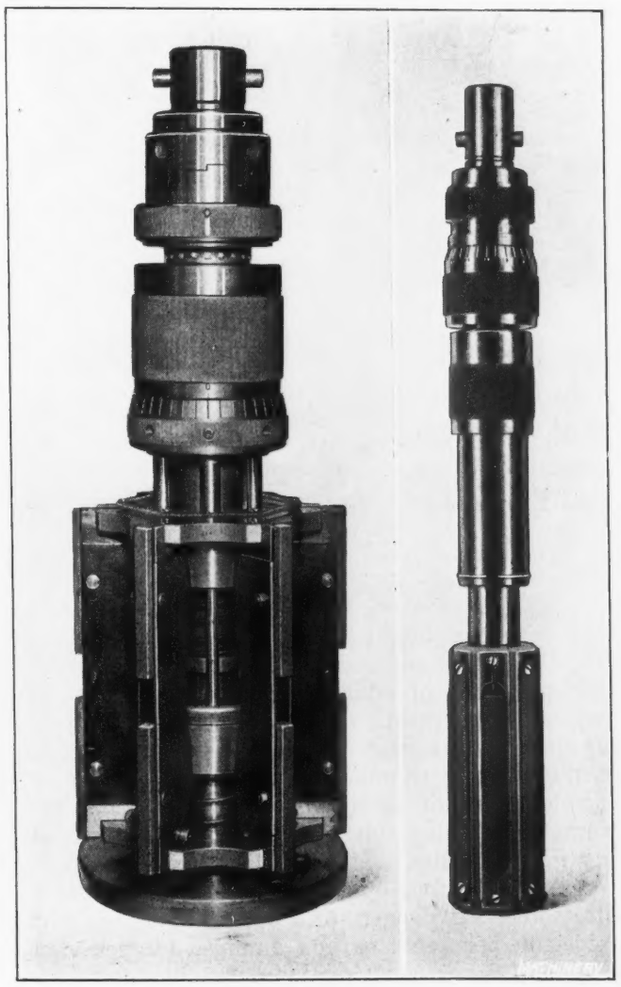


Fig. 12. (Left) Ratchet Type of Hone for Diesel Engine Cylinders. (Right) A Small-diameter Hone with Non-abrasive Guides

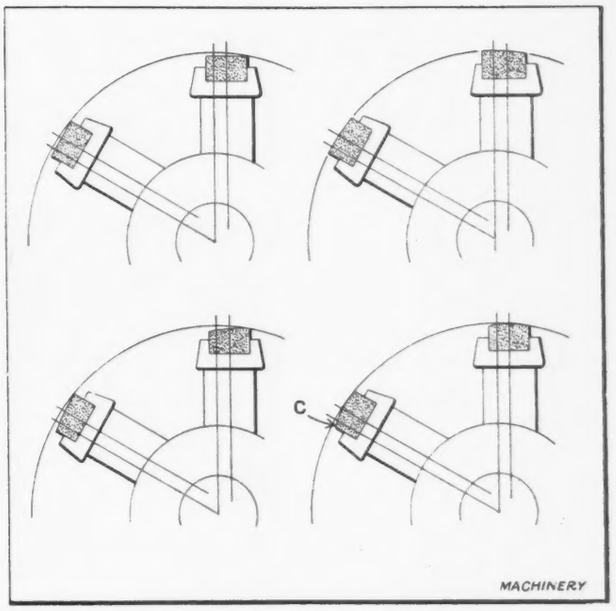


Fig. 13. Diagrams Showing How the Abrasive Stones of Hutto Hones Should be Reset from Time to Time to Prolong their Life

* * *

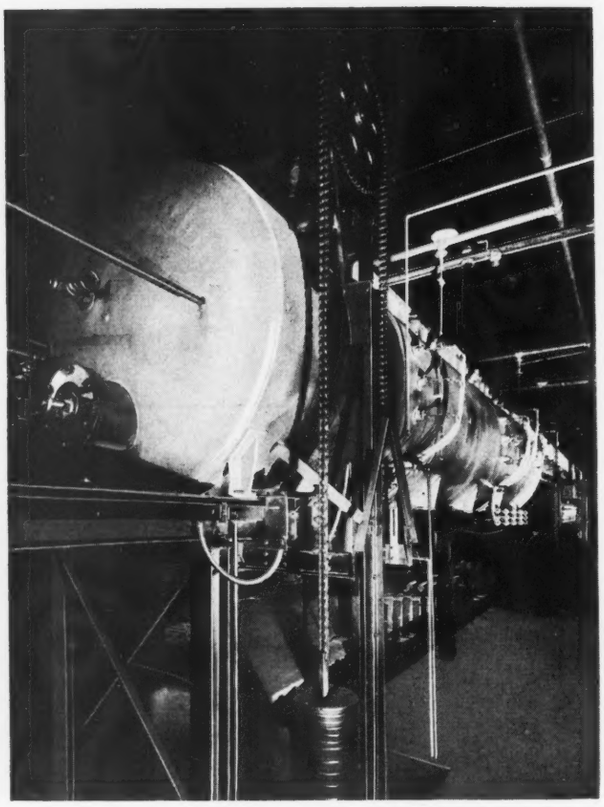
Recommended Practice for Gear Purchasers

The American Gear Manufacturers' Association, at its meeting in May, adopted as recommended practice a set of instructions for gear purchasers, consisting of standardized gearing inquiry forms. Special forms are available for bevel, helical, herringbone, spiral, spur, and worm gearing.

These instructions have been prepared because gear manufacturers have found that many gear users do not always recognize what information the gear manufacturer requires in order to make gears that will meet the customer's needs. Therefore, to make it easier for the customer to outline his requirements and to enable the manufacturer to make gears exactly as desired, a set of sample specification sheets were prepared that show all the dimensions required by the gear manufacturer. Copies of the instructions can be obtained by addressing J. C. McQuiston, Manager-Secretary, American Gear Manufacturers' Association, First National Bank Bldg., Wilkinsburg, Pa. These standardized forms will undoubtedly prove of considerable value to all who have occasion to order gearing.

Producing Strong Joints by Hydrogen Welding

THE term "hydrogen welding" is applied to the process described in this article because the welding is done in an atmosphere of which hydrogen is the chief constituent. The hydrogen atmosphere maintained in the welding chamber of the electric furnace is referred to metallurgically as "reducing"—that is, it not only has no tendency to cause oxide scale on the work, but, on the contrary, serves to reduce any oxide present. Under such conditions, the work comes from the welding furnace with a clean metallic surface. Thus, the hydrogen used in this welding process has no part in supplying heat for welding, as might be inferred from the term "hydrogen welding."



Closely Fitted Joints of Assembled Parts of Iron and Steel are Welded by the Aid of Copper in the Hydrogen Atmosphere of an Electrically Heated Furnace

The hydrogen welding process is used for welding either iron or steel parts. The usual procedure is to so design the two pieces to be joined that they are a press fit, one within the other, at the point of welding. After the parts have been pressed together, a ring of copper wire is applied at the point to be welded. The work is then subjected to the required temperature in the hydrogen atmosphere of the welding furnace.

At the plant of the Bundy Tubing Co., Detroit, Mich., the furnace used for hydrogen welding is popularly known as a "Zep." This name was derived from the similarity of its appearance to a Zeppelin type of airship, as shown by the heading illustration. The success of this company in applying hydrogen welding to the manufacture of copper-coated steel tubing indicated that the process might be applied to many other classes of work for which similar welding operations would prove equally advantageous.

As a result, the Bundy Tubing Co., started a custom welding department for performing hydrogen welding operations for outside concerns, using equipment and methods described in this article. Incidentally, the welding operation on the tubing made by this company is of considerable interest, as it requires the welding of an extensive surface area.

This particular tubing is made by coating a ribbon of steel with copper, then rolling it to produce tubing of the cross-section shown in Fig. 1, and finally, subjecting it to the hydrogen welding process. Previous to this application of hydrogen welding, tubing of double-wall construction like this was made with soldered or brazed joints, as described in April, 1925, MACHINERY.

The furnace shown in the heading illustration is lined with firebrick and is carefully insulated against heat losses. The required temperature is secured by means of six electric elements, each of which is furnished with an individual temperature recording gage. These heating elements are located along the sides and bottom of the heating chamber in the furnace. The atmosphere containing hydrogen in the heating area is known as "Electrolene" and is made by treating city gas with steam at a temperature of 2000 degrees F. The following is an average analysis of Electrolene: Hydrogen, 58.4 per cent; carbon monoxide, 30 per cent; carbon dioxide, 1.2 per cent; oxygen, 1.2 per cent; methane, 1.7 per cent; and nitrogen, 7.6 per cent.

An endless chain conveyor enters the furnace at the heating end, leaves at the opposite end, and returns under the furnace. This conveyor is equipped

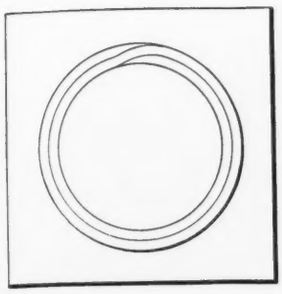


Fig. 1. Cross-section of Double-wall Tubing Rolled from Flat Ribbon Stock and Hydrogen-welded

with suitable carriers for the work being handled. Each carrier is furnished with a projection extending up through a channel in the base of the furnace. This construction prevents the carriage from being damaged by the high temperature to which the work must be exposed inside the furnace. The heating area extends about one-third the length of the furnace. In this area, the temperature is maintained at 2100 degrees F. The conveyor carrying the work is advanced through the furnace by intermittent steps, the entire operation of the furnace being automatic.

Progressive forward movements of the conveyor are obtained by means of hydraulic power, a ram serving to push forward each loaded carriage as it enters the furnace on its way through the heating area. Each of these forward movements forces a carriage loaded with a finished lot of welded work out of the furnace at the opposite end every four minutes. The last two-thirds of the length of the furnace comprise a cooling area which is separated from the heating area by a wall having an opening just large enough for the carriers loaded with work to pass through. The work is moved progressively through the cooling area and is ready for removal when the carriage leaves the furnace.

The carriers are made of iron having a high chromium content, because experience has shown that there is no danger of the carriers being welded to the work when they are made from this material. As the work progresses through the heating area, the temperature of both the material to be welded and of the copper wire wrapped around the work at the joint is raised to 2100 degrees F. This brings the iron to a red heat and the copper to a temperature above its melting point. As the surface of the iron is kept free from oxide by the reducing atmosphere, capillary action causes the melted copper to flow over the two surfaces that are to be welded together. In the finished work, it may appear that the melted copper has spread over the material, and, as a result, a joint welded in this way has the appearance of having been brazed.

In the laboratories of the Bundy Tubing Co., evidence has been produced to show that the term "brazing" is a misnomer when applied to hydrogen welds. Proof of this is shown by the two photomicrographs in Fig. 2. The upper view shows the joint before welding, and the lower view the joint after welding by this process. The lower view shows that the copper penetrates into the iron, there being evidence of crystals that are completely surrounded. This penetration of the copper is not an infiltration, but is a definite alloying of the copper and iron, which produces a material that analyzes 97 per cent iron and 3 per cent copper. On this basis, the company's metallurgists maintain that the process is one of true welding and not in any sense a process of fusing copper between the two surfaces of the joint to hold them together.

Strength of Hydrogen Welds

Under the familiar forms of physical tests such as are applied to parts joined by hydrogen welding, the strength of the welded joints also indicates that the process is one of welding and not of brazing. Fig. 3 shows a welded tank after having been subjected to physical tests to determine the relative strength of the hydrogen-welded joint and the material from which the tank is made. This steel tank, assembled from a length of tubing, two stamped end plates, and a screw machine threaded fitting, with all joints hydrogen-welded, burst at 2200 pounds hydraulic pressure, but there was no failure of the hydrogen-welded seams at any point. This shows that there is a bonding together of the material in a way that makes the joint metal in many cases stronger than the surrounding metal. Such would not be the case if the joints were brazed.

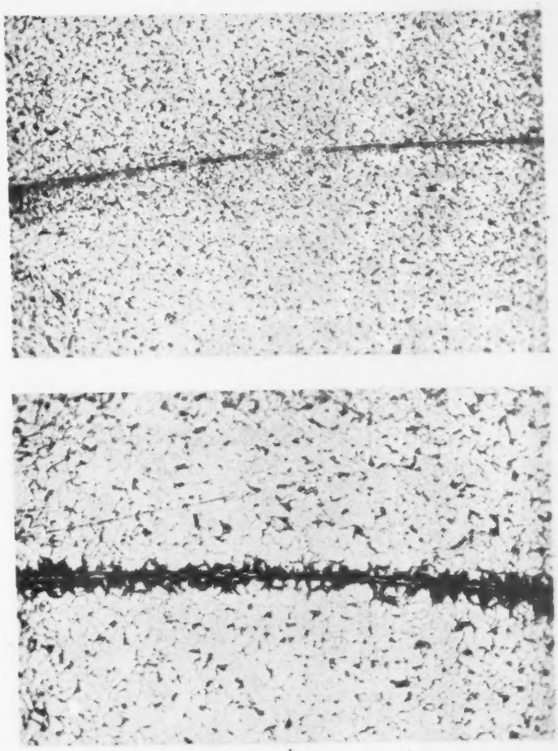


Fig. 2. (Upper View) Photomicrograph of Two Pieces of Steel Prepared for Hydrogen Welding, Showing Sharply Defined Cut through Grain Boundaries. (Lower View) Same Section as Shown above after Welding, Showing how Copper-iron Alloy (Black Area) Extends Well into the Grain Structure

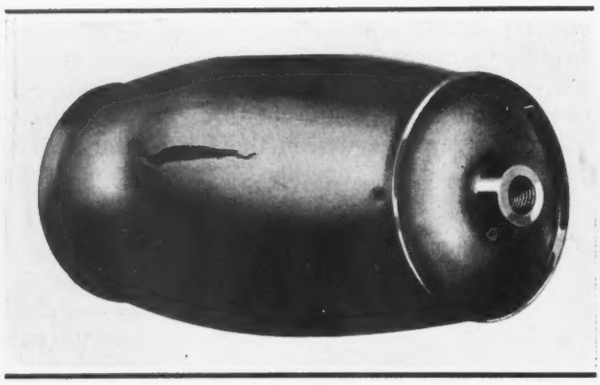


Fig. 3. Steel Tank Assembled from Four Parts with All Joints Hydrogen-welded. Side of Tank Failed at 2200 Pounds Hydraulic Pressure, with no Failure of Welded Seams

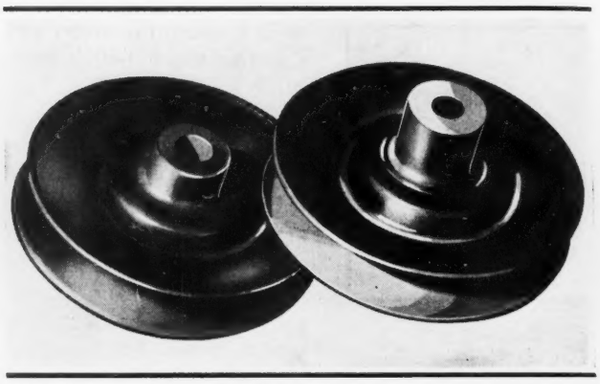


Fig. 4. Pulley at Left Machined from Casting with Obvious Waste of Material and Labor, as Compared with Three-piece Hydrogen-welded Pulley Shown at Right

Double-walled steel tubing welded by the copper-hydrogen-electric method, when tested by the Detroit Testing Laboratory, showed a tensile strength in excess of 50,000 pounds per square inch and an average elongation of 30 per cent in 2 inches. Twelve tubes were used in these tests. The outside diameter of the tubes tested was 3/8 inch and the thickness of the welded double walls 0.032 inch. In no case was there a failure of the welds in these tubes.

Advantages of Hydrogen Welds

Hydrogen welding cannot be considered as competitive with other recognized methods of welding together parts of metal products. More correctly, hydrogen welding should be regarded as a process that further extends the range of work that can be successfully assembled by welding. It provides an economical and efficient method of uniting into a dependable unit parts of metal products which are produced by stamping, drawing under power presses, or machining on automatic screw machines. Thus, two or more parts of this kind can readily be assembled by hydrogen welding to produce parts that could not be made as a single unit.

The parts shown at the right in Fig. 4, for example, are easily assembled and then welded into a solid gas-tight structure, such as shown in the view at the left, by a single passage through the hydrogen welding furnace. Hydrogen welding thus becomes an important factor for the engineer to consider in designing various units of a product.

The pulley shown at the left in Fig. 5 was machined from a rather intricate casting with an obvious waste of material and a considerable cost for labor. The pulley at the right was assembled from two simple castings and a bushing made on a screw machine, the three pieces being hydrogen-welded together into a single unit of improved appearance, greater strength, and less weight. These features are important factors from the standpoint of the engineer who must produce a product that will make the greatest possible appeal to prospective purchasers and that will give the most efficient service under average conditions.

It is obvious that a method offering as many advantages as hydrogen welding will gradually find an ever increasing number of applications in industry. A thorough understanding of the method and its possibilities is, therefore, of particular importance at this time.

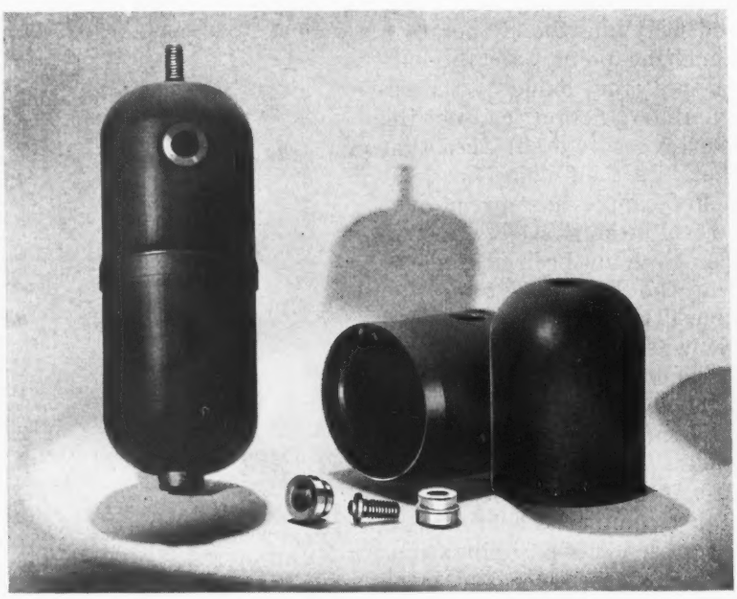
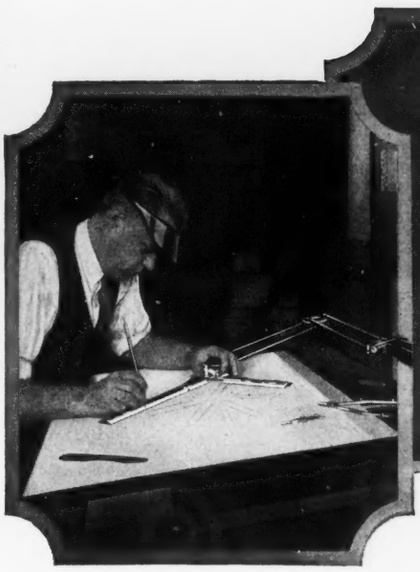
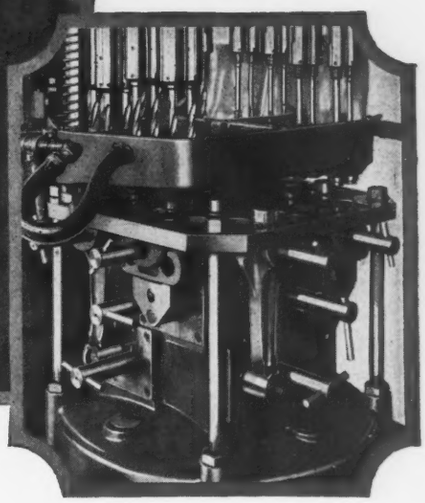


Fig. 5. The Small Cylindrical Tank Shown at Left was Assembled from the Two Drawn Shells and Three Machined Parts Shown at the Right, which were Welded into a Solid Gas-tight Structure by One Passage through a Hydrogen Welding Furnace



Design of Tools and Fixtures



Indexing Fixture for Turning Double Eccentrics

By CHARLES C. TOMNEY, Chief Tool Designer
Carrier Mfg. Corporation, Newark, N. J.

The peripheries of two opposing eccentrics that are cast integral with a relatively long sleeve are machined rapidly in a turret lathe without disturbing the set-up by means of the fixture shown in Figs. 1 and 2. Both eccentrics are offset 1 inch and are 3 1/8 inches in diameter. The sleeve, having a 13/16-inch bore, is held on an arbor, one end of which is secured in the indexing fixture, which is bolted to the face of the lathe chuck, the jaws being removed. On the other end is a throw block having two parallel prongs, the center lines of which coincide with those of the eccentrics.

One of the prongs, depending upon which eccentric is being turned, engages a ball bearing mounted in a shank secured in the turret, thus providing a rigid support for the outer end of the sleeve. The turning is done by means of the cross-slide, equipped with a tool turret so that resetting of the tools between the roughing and finishing cuts is avoided.

The fixture consists essentially of the body *A*, the index-plate *B*, which is fastened to the bushing *C* by screws, and the work-arbor *D*. The work is indicated by dot-and-dash lines. Three slots *E* cast in the body provide a means for bolting the fixture to the face of the chuck. Although the jaws are removed from the chuck, slots are also cast in the body to provide clearance for the jaw bases which protrude beyond the chuck face. Plug *F* enters the center hole in the chuck and thus centralizes the fixture.

Bushing *C* is a turn fit in a hole bored in the body and, together with index-plate *B* and arbor *D*, is eccentric with the center of plug *F*. The amount of this eccentricity is equal to that of the eccentrics to be turned. Bushing *C* is retained in the body by plate *G*, and contains a concentric hole in which the arbor *D* is a snug fit. The flange of arbor *D* is secured to the bushing by screws. With this arrangement, the arbor can be removed from the fixture in case repairs are required.

Index-plate *B* contains the two bushings *H* which are engaged by the plunger *J*. On plunger *J* is mounted the latch *K*, which is pushed back by the operator to disengage the plunger from the index-plate, in order to allow the plate to be rotated 180 degrees to its next position. To exclude dirt from the fixture, the outer ends of the plunger bushings in the index-plate are closed by small disks driven into place. Provision is made for lubricating the bushing *C* by an oil-hole (not shown) which delivers the oil to point *R*.

At the right-hand end of the arbor is the throw block *L* containing two prongs *M*. The throw

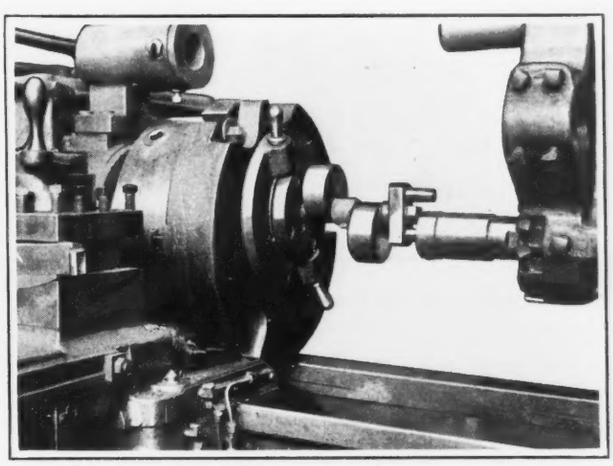


Fig. 1. Turret Lathe Set-up for Turning Two Opposing Eccentrics Integral with a Long Sleeve. Note the Ball-bearing End Support in the Turret for the Outer End of the Sleeve

block has two keyways. It is bored to fit the arbor and is secured to it by a nut. This nut also serves to clamp the eccentric sleeve rigidly on the arbor. It will be noted that one of the prongs is in engagement with a ball bearing mounted in shank *N*. The shank, in turn, is mounted in the lathe turret. Incidentally, the cap *S* serves to retain the bearing in the shank and also to exclude dirt and chips.

the turret is moved back to disengage the prong and ball bearing. Latch *K* is then pushed back and the operator grasps the handles on the index-plate and swings this plate 180 degrees, at which point the plunger will engage the other bushing in the index-plate. Thus the arbor is brought into position for turning eccentric *P*.

Supporting the work at the right in this way is

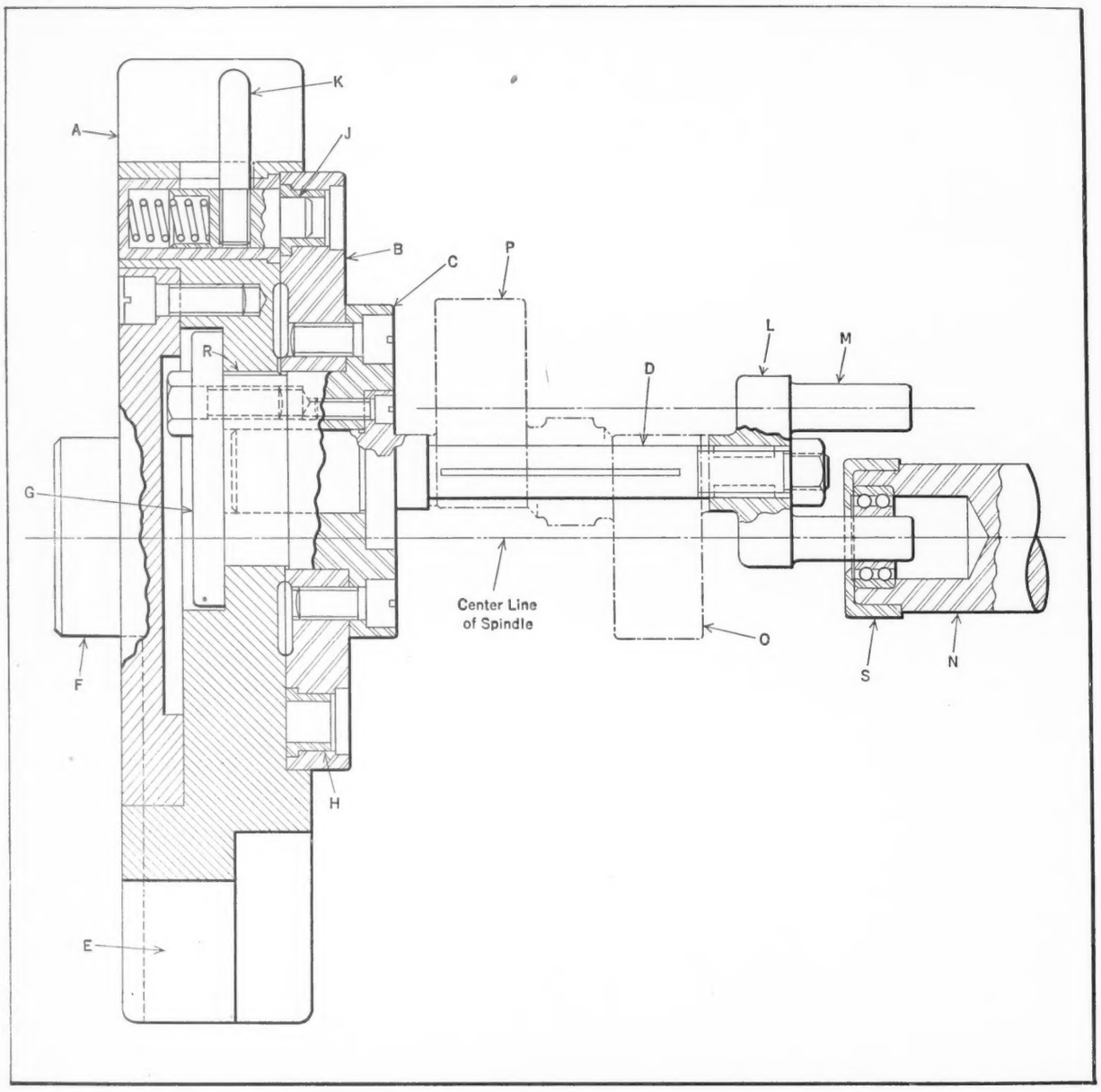


Fig. 2. Construction of the Indexing Fixture and Ball-bearing Support Shown in Fig. 1

In loading and unloading the work, the throw block must be removed from the arbor. In preceding operations, the eccentric sleeve is bored, faced, and the keyway cut. In the position indicated, eccentric *O* is in position to be turned, since its center line and that of the lower prong coincide with the lathe spindle center line.

In order to index the fixture to turn eccentric *P*, superior to the use of a center, since a great deal more time is consumed in adjusting and lubricating the center to prevent springing of the arbor and overheating of the center. Moreover, any axial expansion of the arbor, due to heating of the work, only causes the prongs to slide in the inner race, so that no strains are set up to distort the work, as would be the case if a center were used.

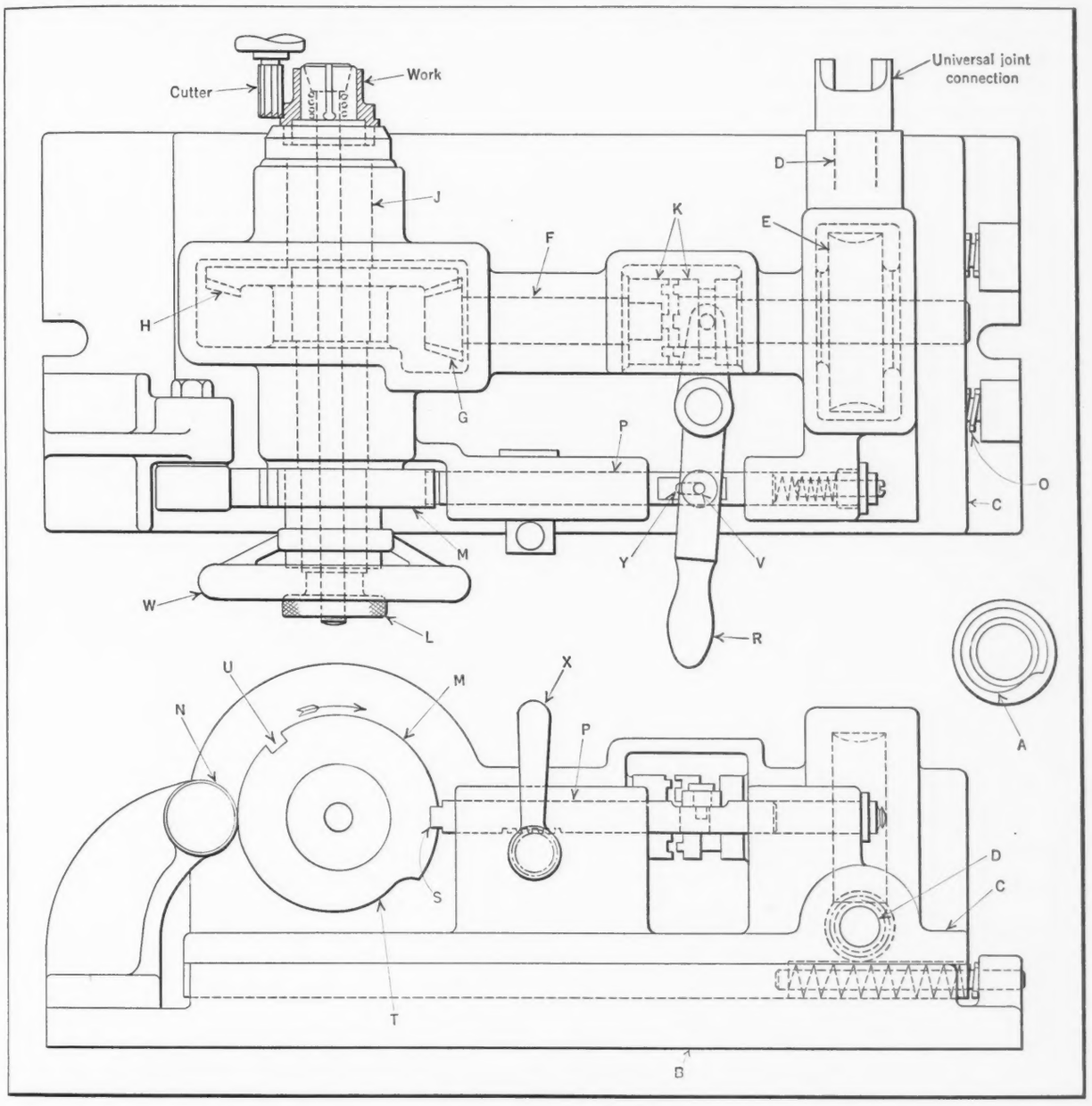
Cam Milling Fixture with Automatic Stop

By FRANK W. CURTIS, Research Engineer
Kearney & Trecker Corporation, Milwaukee, Wis.

The fixture here illustrated is used for milling the cam face of the clutch shown in detail at *A*. It is of the automatic type, embodying several novel features, and is of a design that can be used for a large variety of cam milling operations.

The base *B* remains stationary on the machine table, and the slide *C* that carries the drive, slides on dovetailed ways on the base. When the fixture is in operation, the machine table is locked. The drive to the fixture is taken from the table feed-shaft, which is attached to the universal joint connection on the worm-shaft *D*. If this form of drive is not available, a connection can be made from the end of the table screw. In this case, the feed-nut is disconnected, and the fixture is driven through bevel gears.

Worm-shaft *D* operates the worm-wheel *E*, which drives the longitudinal shaft *F*. At the left-hand end of this shaft is mounted the bevel gear *G* which drives the larger bevel gear *H* attached to the fixture spindle *J*. The clutch *K* is provided so that rotation of the spindle can be discontinued, regardless of the operation of the machine. The work is mounted on the end of the fixture spindle, and is held by an expanding collet operated by the draw-

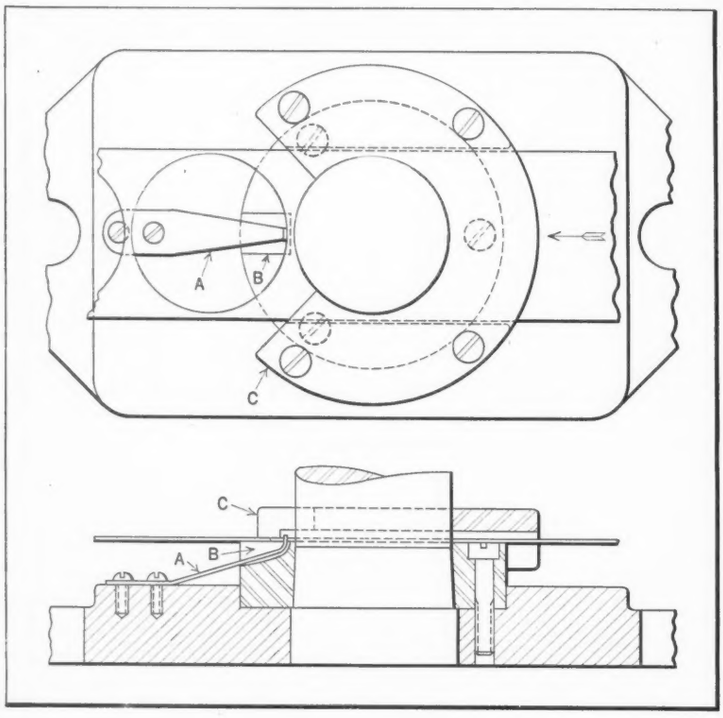


Cam Milling Fixture with an Automatic Stop for Forming the End of the Cam Contour to the Curvature of the Cutter

bar handwheel *L*. At the other end of the spindle is located the master cam *M*, which engages the stationary roller *N*. The two stiff helical springs *O* force the sliding part of the fixture to the left, so that the master cam and roller are always in contact with each other.

With this arrangement, it is obvious that the slide *C* will be reciprocated by the master cam. An automatic stop is provided, consisting of the plunger *P* which engages the slots in the master cam, and a pin *V* on the clutch lever *R*.

Assuming that a piece to be milled has been clamped on the collet, the operator shifts the clutch handle *R* to the right. This motion engages the clutch and withdraws the plunger from the slot *S* in the master cam, allowing the spindle to rotate while the cut is being taken.



Simple Stop Arrangement for a Blanking Die which Bends the Strip to Allow it to Pass over the Stop

At the end of the cut, the plunger *P*, which is backed up by a spring, engages the slot *U*. This disengages the clutch through the pin *V*. After the work is removed, the spindle is returned to the starting position by the large handwheel *W*. To do this, however, the lever *X* is thrown to the right to withdraw the plunger from the slot *U* and thus unlock the spindle. The elongated slot *Y* in the plunger is provided to enable the plunger to be withdrawn without causing the clutch to be engaged. When the starting position of the cam has been reached, the plunger drops into the slot *S* and the fixture is again loaded. If pieces having slightly different cam profiles are to be milled, additional master cams can be provided. Other collets can also be made to suit different pieces.

A Simple Gage Stop for Blanking Dies

By CHARLES H. WILLEY, Penacook, N. H.

Various types of stops are in use for spacing the strip in blanking dies, but aside from the simple solid pin-stop, they are usually complicated in design. A rather simple stop, which is not only economical in construction but is claimed to be highly efficient as well, is shown in the illustration. It can be applied to old dies as well as to those being constructed. An outstanding advantage of this stop is that the operator need only exert a horizontal pull on the strip to feed it along instead of lifting it for each feeding movement, as is required when a solid pin-stop is employed.

The stop consists chiefly of the blade *A*, which is attached to the die-bolster by screws. A recess *B* is ground out at one corner of the die to receive the blade and to locate the bent up tip of the blade in the correct position for spacing the strip. The stripper plate *C* is cut away near the blade for reasons that will be explained later.

In operating this die, the strip is fed under the stripper plate and against the vertical tip of the blade. The punch then descends and blanks out the disk. As the press ram ascends, the punch carries the strip up against the stripper plate, and the part of the strip adjacent to the left side of the punch is bent upward by the angular opening in the side of the stripper plate. When the punch finally leaves the strip, the bent portion of the strip is above the vertical tip of stop *A*, so that the strip can be moved along to blank the next disk.

The writer has applied this stop arrangement with satisfactory results to more than one hundred blanking dies of various types for stock, the thickness of which did not exceed 1/16 inch. There seems to be no reason, however, why it could not be applied to stock of greater thickness if desired.

* * *

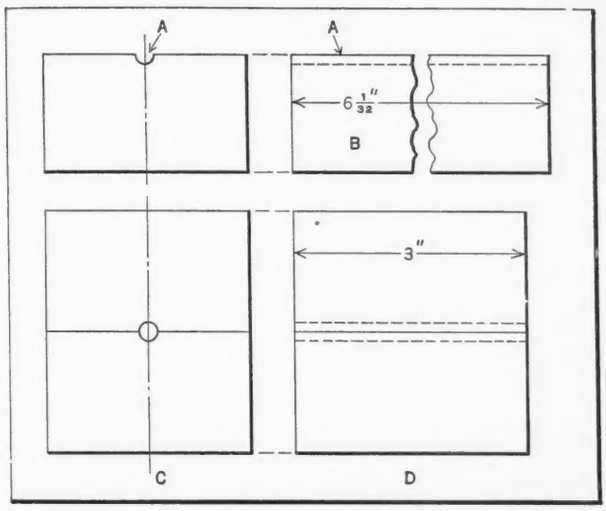
A novel photo-electric installation has been made at the plant of the National Enamel & Stamping Co., Granite City, Ill. A General Electric photo-electric relay controls a belt conveyor in the enameling plant. The relay is used at the end of the conveyor to prevent the work from piling up at that point. Operators stationed at different points along the conveyor apply the beading to the ware and place it on a chain conveyor, which transports it through the enameling furnace. If the last operator misses a piece, the beam of light is interrupted, and this, in turn, shuts off the conveyor motor. As soon as the operator picks up the piece, the conveyor automatically starts again.

Ideas for the Shop and Drafting-Room

Time- and Labor-Saving Devices and Methods that Have been Found Useful by Men Engaged in Machine Design and Shop Work

Drilling True Half-Holes

Accurate or true half-holes can be easily drilled by the following method: A finishing cut is taken on the top of a piece of stock *B*, which is twice the length of the piece required. A small semicircular



Diagrams Illustrating Method of Drilling Half-holes

groove *A*, as shown in the accompanying illustration, is then cut lengthwise of the finished face of piece *B*. The piece is next cut off at the middle point, and the two faces are clamped together, as shown by the views *C* and *D*. The small grooves in the pieces form a round hole, which serves as a starting center and guide for drilling half-holes of the required diameter in the two pieces. Half-holes of great length can be accurately drilled in this way.

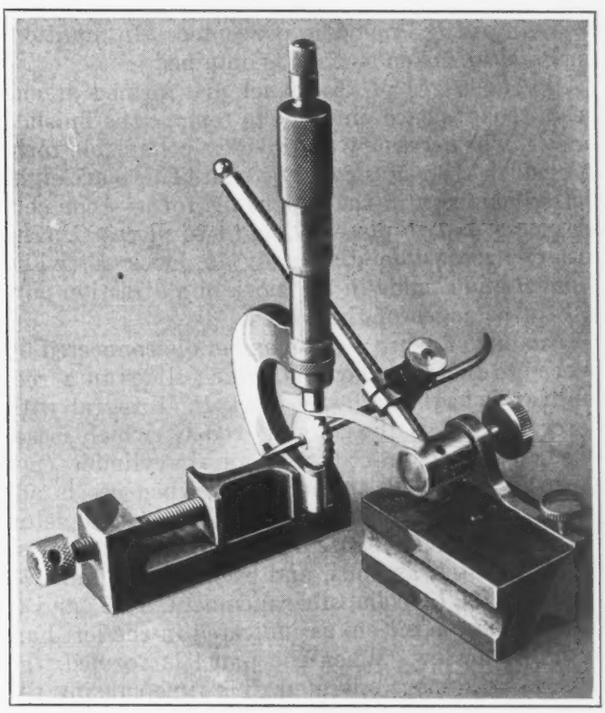
Rochester, N. Y. HENRY W. MASS

Measuring the Outside Diameter of Gears Having an Odd Number of Teeth

Recently the writer received an order to make some duplicate gears and ratchets for a projection machine. Sample gears were furnished with the order, but since they had an odd number of teeth, it was impossible to measure the outside diameters directly to determine the size of the blanks. This difficulty was overcome by using an ordinary surface gage, a toolmaker's clamp, and a micrometer —all standard equipment. As indicated in the illustration, the micrometer is held upright in the clamp. One of the gears is supported between the measuring points of the micrometer by the scriber of the surface gage.

By adjusting the gage in the usual way, the gear is lowered until one of its teeth, when coinciding with the vertical center line, just touches a piece of cigarette paper laid on the anvil of the micrometer. The gear is then rotated a distance equivalent to one-half the circular pitch of the teeth. The micrometer spindle is now fed down until it just touches a piece of the cigarette paper held over the top tooth. The resulting micrometer reading is the outside diameter of the gear plus twice the thickness of the cigarette paper. In this way, a direct, accurate measurement is obtained.

Hamilton, Ont., Canada H. MOORE



Rotating a Gear Having an Odd Number of Teeth on a Surface Gage Scriber to Measure the Outside Diameter

Removing Grinding Dirt from a Magnetic Chuck

A strip of wood 3 or 4 inches wide and of suitable length is excellent for scraping or wiping the grinding dirt from the face of a magnetic chuck on a wet surface grinder. S. B.

Collapsible Die that Forms Twelve Bends at One Stroke of the Press

By Forming the Bends Successively, Stretching or Rupturing of the Metal is Avoided and an Unbroken Surface is Obtained

By ANDREW BEUSCH

TWELVE separate bends on the four edges of a rectangular sheet-metal door panel are formed during one stroke of the press in the die shown in the accompanying illustration. The right-hand side of the die shows the ram at the top of its stroke, and the left-hand side at the bottom. The punch-plate is omitted in the plan view to show more clearly the action of the forming members.

A section of one edge of the finished panel is indicated at the upper right-hand corner. The die is designed so that the three bends at each edge of the blank, which is previously notched at its corners, are accomplished successively. In this way, as each successive bend is made, the stock is readily drawn from the free edge of the blank and excessive stretching of the metal is prevented. In addition, a smooth unbroken surface is obtained.

All four edges of the panel are formed at one press stroke; hence, in order to remove the finished panel, it was necessary to provide a collapsible form over which the edges could be bent. There are eight sliding members in the collapsing form—four corner pieces *A*, two pieces *B*, and two pieces *C*. The corner pieces slide diagonally in block *E*, while pieces *B* and *C* slide in the block in a direction parallel to the edges of the panel.

Each one of these eight members is connected by links *F* to the cross-head *D*, which slides in a rectangular hole through the block *E*. Integral with the cross-head is the vertical rod *G*, which is secured to the piston-rod *H* of an air cylinder (not shown). With this arrangement, when air is admitted automatically to the bottom of the piston by a button valve mounted on the press in the usual way, the piston ascends, and by means of links *F*, forces the eight collapsible members *A*, *B*, and *C* to their outer position, as indicated in the left half of the plan view. When the panel is formed, the valve is once more operated, this time causing the air to enter the top of the piston and move the collapsible members to their inward position, as indicated in the right-hand half of the plan view. The panel can then be readily removed without interference with the form.

Aside from the collapsible form, all the forming members are mounted in the punch-block *J*. This block is equipped with two spring-actuated plates *K* and *L*, the tension of which is adjusted so that the lower plate will be compressed before the upper one. The construction of the forming members can be readily seen by referring to the right-hand end of the die. Forming slide *M* is mounted on the U-shaped arm *N*, which is pivoted on pins *O*, the latter coinciding with the center of the radius for the second bend. Pivot pins *O* are provided for this arm on both sides of the die and are supported in projections on plate *K*. It will be noted that at the upper end of slide *M* is hinged a link *P*, which is pivoted in the punch-plate. This link serves to swing the arm *N* downward, as will be explained later. Angle-piece *Q* is secured to the die-block and serves as a guide for arm *N* when it swings downward.

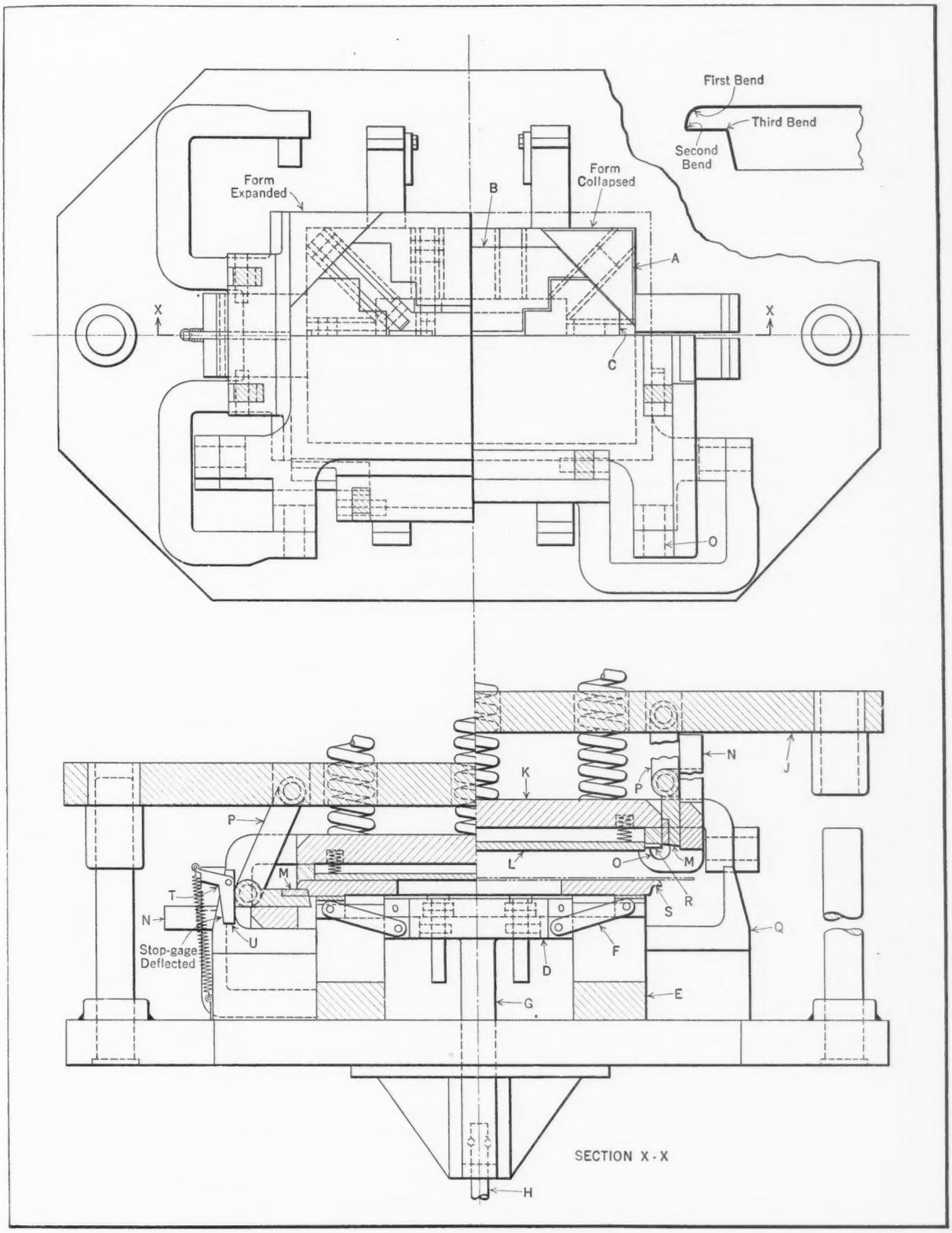
In the sectional view at the right, the punch-block is shown at the top of its stroke. The blank, indicated by dot-and-dash lines, is located on the expanded former in the die-block by stops. As the ram descends, plate *L* comes in contact with the blank; and as the ram continues downward, this plate remains stationary and block *R*, secured to plate *K*, forms the first bend. It is important that the springs backing up plate *K* be of sufficient strength to resist deflection until this bend is made.

Upon the continued downward movement of the ram, plate *K* remains stationary, so that the link *P* forces slide *M* down past the edge of the collapsible form. When the left-hand lower corner of the slide has traveled past the shoulder *S* of the form, the slide meets a stop (not shown) on arm *N*. Thus, as the ram continues to descend, link *P* swings arm *N* on pivot *O* in a clockwise direction.

Arm *N* is swung in this way through an angle of 90 degrees, so that the link boss on slide *M* comes in contact with the inside of the vertical lug on guide *Q*. This contact results in forcing the slide inward, which completes the second bend; and as the slide continues its swinging movement, it forms the third and final bend, as indicated at the left of the sectional view. At this time, the ram is at the bottom of its stroke. On its return, the members of the die pass through the movements described in the reverse order, and the air valve is automatically depressed; this causes the form to be collapsed, thus permitting the finished panel to be removed from the die.

The stops for locating the blank are placed at the rear and at the left-hand side of the die. One of these is shown at *T*. When the ram is up, these stops are held by coil springs so that ends *U* are vertical and against the blank. When the ram descends, they are pushed downward out of the path of slide *M* by the slide itself.

This is an ingenious arrangement for accomplishing what, at first glance, would be considered



Die for Forming Three Bends Successively on Each Edge of a Door Panel. Die is Shown Closed at the Left and Open at the Right in the Sectional View

a most difficult operation and one that could not be performed at one stroke of the press. Furthermore, it might be supposed that it would hardly be possible to form these bends at one stroke without rupturing, or at least unduly stretching, the metal; but this difficulty, as will be noted, is overcome by forming the bends successively, so that excessive stretching is prevented.

The Manufacturer and the Industrial Recovery Act*

By JAMES W. HOOK
President, The Geometric Tool Co.
New Haven, Conn.

JUST what is there about the Industrial Recovery Act that manufacturers do not like? As manufacturers we surely do not object to the opportunity it affords to stamp out bad competitive practices that have been stifling industry for so long. We do not object to uniform accounting systems and the opportunity to stop the practice of selling below cost. We do not object to being given the chance to stamp out the evils of trade-in allowances, secret rebates, unreasonably free servicing, and the copying of each other's designs. We cannot object to the opportunity of forcing our bad competitors to pay decent wages, such as others among us already pay, and of making them refrain from exploiting labor with a view to reducing costs and under-cutting the prevailing price level.

Every one of these practices has been deplored by legitimate industry for decades. Why, then, do many manufacturers object now to letting the Government back us in our efforts to eliminate these practices?

Some will say that we do not want the Government to run our business; we do not want to be hampered in the free exercise of our judgment by Government agents; we want our liberty and we are willing to put up with a good many evils in order that we may have it.

A Broader Basis for Industrial Management

Well, that is one reason, of course, but I wonder if it is precisely the real reason. Suppose the Act had applied the force of Government just far enough to support us in dealing with the evils enumerated —but no farther. Would we have objected? I doubt it. By and large, I believe that we would have applauded such a high-minded attitude of Government that recognized the difficulties that we as managers and owners must meet, and that offered us Government backing in our efforts to eliminate them.

What we object to, I believe, is the fact that our Government which is the Government of all the people, regardless of their individual interests, introduced into the new law some clauses that intimate that those who work in industry, as well as those who own and manage it, shall have some say about matters that directly affect them; such, for instance, as wages, hours, and conditions of employment.

This is by no means a new conception. The better employers of the country have long admitted employe opinion to help shape policies. The difference is that in the past, employers had a veto power which enabled them to shape their decisions as desired, and to enforce them regardless of any employe advice that had been given. Now the veto power is, by the Industrial Recovery Act, put into the hands of an agency of the Government, whose decisions shall govern.

Manufacturers as employers object to this usurpation of their prerogatives. They fear that the Government agency may not decide correctly or in line with their own judgment. They fear that this agency may be unduly influenced by labor organizations. They fear that it may force them to forego profits in good times by boosting wages, and thus leaving them without reserves to carry through bad times. They wonder if they can safely subordinate their own judgment in affairs dealing with business to the judgment of a Government agency.

Well, that remains to be seen. I have wondered just how I should feel if a Government agent came into my plant, looked over my books and records, and finally ordered me to raise wages and reduce hours. I think I should feel pretty resentful and, perhaps, show my feelings in no uncertain manner. Yet if, upon reflection, I could feel assured that all of my competitors were being forced to operate under similar conditions, I might not feel so badly. That would be a condition, I would be forced to admit, that was not obtaining before the law was passed. It was a condition that I had always felt should obtain. Why, then, should I object to it now? For only one reason, so far as I can see: I might

*Abstract of a paper read before a special meeting of the National Machine Tool Builders' Association, Cleveland, Ohio, July 13, 1933.

fear that the Government was not enforcing the law upon the others as it was on me.

What the Industrial Recovery Act Proposes to Do

The law permits an industry to establish a code or set of rules under which it will operate. This code can be made to set forth the practices that are considered unfair competition and, therefore, taboo. It can be made to establish the relationship between employer and employe. All members of an industry, as well as employes in the industry, may have a say in establishing the code. Those who refuse to accept it, once a majority agrees upon it, will come under the special scrutiny of the Government (and even licensing in some cases by the Government) to see that unfair practices are not engaged in. I can hardly conceive of a company being so stubborn as to force such special conditions upon itself.

Once a code is accepted, a company having reason to believe that a competitor is not living up to its requirements may file a complaint and bring the offending one on the carpet. Thus we have self-regulation backed by the force of law, to the extent that we desire to make ourselves the regulators.

Labor also comes within the control of the Act, once industry adopts a code and gets it accepted. Unfair action on the part of a labor union, or a group of workmen, may, if the code has been properly drawn, be penalized. This is something that is not possible now, except in special and well defined cases. The freedom of labor to attack a single unit in any industry will, I believe, be impossible if codes are properly drawn and lived up to by industry itself. There will doubtless be continuous pressure on the part of organized labor to increase wages and shorten hours, but Government would not dare let these demands go too far for fear of endangering the life of business itself.

Prompt Action on the Part of Industry is Highly Important

The advantages that may accrue to Industry are possible, of course, only if Industry rises promptly to its opportunity under the Act. If it delays, it will find organized labor soliciting its employes to join established unions, as a means of obtaining benefits under the Act. If it acts with reasonable speed, presents a well thought-out code, and gets it accepted, agitation on the part of labor on the one hand, and unfair employers who profit by bad competitive practices on the other, will not get very far. The great opportunity for the organized groups in either of these fields lies in the interim between the present and the time when an industry begins to operate under a code. For that reason I urge that the great metal-working industry of which we are a part draw up its code just as quickly as it possibly can. The more companies operating under a single code, the better. Too many codes would permit varying practices that might in themselves develop into destructive competition.

In establishing any code, there should be an effort made to reach strictly intrastate concerns. It should not be possible for a small "pirate" concern to set itself up in a single great industrial state and copy the product of interstate firms for the local market, under employment conditions not permitted to interstate firms under the Act. Herein lie the greatest dangers under the Act. If intrastate firms cannot be reached, it is quite possible that the Act, by regulating only interstate firms, will result ultimately in creating the equivalent of tariff barriers between the states. This will be the case if, under the Act, intrastate firms grow in large numbers.

How the Law Can be Made to Apply to All Competitors

There are three ways of reaching the intrastate firms: *First,* for the Government to require each industry submitting a code to define as being unfair practice the purchasing of mechanically exact copies of specialty products made by a legitimate firm engaged in serving the trade in more than one state; *second,* for the Government to interpret that otherwise intrastate firms using raw materials that originated without the state where they do their business, come within the definition of firms doing an interstate business; *third,* for the Government to interpret that otherwise intrastate firms supplying any of their products to firms doing business in two or more states come within the definition of firms doing an interstate business.

In conclusion, may I emphasize what to me seems very important—prompt action. The law is on the statute books. The administrative bureau is functioning. Furthermore, early codes will receive more sympathetic attention. If we delay, and are *forced* to act, we stand little chance of getting the most desirable features incorporated. Indeed, we may find ourselves with a code that provides minimum pay and maximum hours, and nothing else—a code that will provide for Government dictation rather than Government regulation.

* * *

International Automotive Congress

The Society of Automotive Engineers is staging an International Automotive Engineering Congress to be held at the Palmer House, Chicago, Ill., from August 28 to September 4. Never before has the Society of Automotive Engineers sponsored such a comprehensive automotive engineering conference as this. More than one hundred outstanding engineers in the automotive field will take active part in the sessions. Not only is it expected that there will be representatives from practically every company in the automotive industry in this country, but there will also be automotive engineers from many foreign countries. Sessions will be held pertaining to almost every branch of automotive engineering. Special attention will be given to aircraft and aircraft engines, and to automotive Diesel engines.

Hardening Impression Dies

The Quenching Methods Described in This Article are Used in Hardening Expensive Dies Employed in the Manufacture of Silverware and Jewelry

By WILLIAM E. SNOW

IMPRESSION dies, such as are used in the manufacture of silverware and jewelry, are among the most costly of the many kinds of dies in common use. The hardening must be performed with great care, in order to obtain the required qualities and avoid the danger of cracking the die or injuring the finished impression, which frequently costs many hundreds of dollars to produce. The methods and equipment used in preparing a typical impression die for hardening, packing it in the carburizing box, and heating it to the required hardening temperature were described in July MACHINERY, page 697. The present article continues the description of the hardening procedure, dealing with both the methods and equipment used in quenching and tempering the die.

Quenching the Die

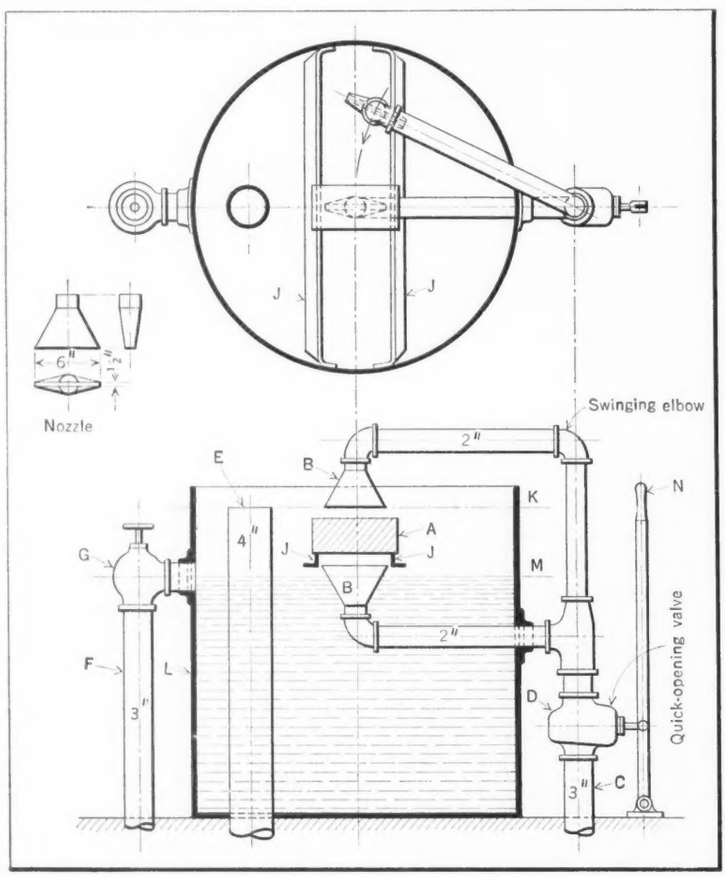
Of all the operations incident to the hardening of impression dies, the quench is the most important, as, in order to avoid brittleness, a steel of lower carbon content is used than is customary in other classes of tool work, and to offset this, it is necessary to depend on the efficiency of the quench to obtain the required surface hardness and depth of case. It is imperative, therefore, that an effective quench be used.

The perfect quench would be an instantaneous one; but this, of course, is not possible to obtain. It takes a certain amount of time to get all the heat out of a thick mass of metal like a die-block. Brine comes the nearest to producing the desired result, but as dies generally crack under such harsh treatment, cold water is usually resorted to for the quenching medium.

There is a direct relation between the time required in the quench to remove all visible redness from the surface of a die and its ultimate hardness. The quicker the heat is drawn out in the quench, the harder will the surface be and the deeper the hardening.

It is impossible to obtain a rapid enough rate of cooling for best results in impression dies by quenching them in a tank of still water, no matter how cold it may be; a specially arranged tank with running water is absolutely essential. Quenched under running water in such a tank, a die-block 4 by 3 by 8 inches in size will lose its visible redness in two minutes or less; but if quenched in a tank of still water, it will retain its redness for four or five minutes, with a corresponding loss in hardness—both as to surface and depth.

There are other reasons, too, why running water is necessary for proper hardening. When a die is put into water for quenching, the heat causes steam to form in the deeper cavities of the face, and this, unless continuously washed out by running water, will interfere with the cooling of this part of the die and cause soft spots on the face. Also, a die cools first on the outer surface, heating the water around it in so doing, and unless this is continuously replaced with cold water, the heat still left in the center of the die tends to draw the surface as it escapes, thus affecting the hardness. To keep the die from warping in the quench, it is necessary that the face and the back be cooled at the



Arrangement of Tank Equipped with Running Water for Quenching Impression Dies

same rate. If this is attended to, the sides and ends of the die can be safely left to take care of themselves.

Arrangement of Quenching Tank

The accompanying illustration shows a simple but effective arrangement of a tank equipped with running water for quenching impression dies. At *A* is the die, supported on the frame *J* in the tank *L*. The elongated nozzles *B* are for spraying the face and back of the die with water. The upper nozzle is mounted so that it can be swung out of the way for convenient handling of the hot die.

The supply pipe to the nozzles is shown at *C* and the control valve at *D*. This valve is of the quick-opening gate type, operated by a lever instead of a screw, which makes it possible to get the full volume of water on the die instantly. This is important. At *F* is the drain pipe, controlled by the valve *G*, for draining the tank to the lower level *M*. The overflow pipe *E* keeps the water at the level *K* when valve *G* is closed.

The tank is operated as follows: The water in the tank is drained down to the lower level *M* by means of valve *G*, which is then closed. The die to be quenched is placed on the supports *J* between the nozzles as shown, and the upper nozzle swung into position over the die. The water is then turned on by opening valve *D*. The nozzles distribute an even flow of water on both the face and the back of the die, and at the same time, the water in the tank rises rapidly from the level *M* to the level *K*, completely submerging the die and cooling the sides and ends. This gives very rapid and uniform cooling without warping the die.

The construction of such a tank is an easy and inexpensive matter. The important thing is to make the tank small and the water-supply pipe large, so that the water in the tank will rise and submerge the die in the shortest possible time. This should be accomplished in less than a minute for best results.

A tank 30 inches square, or a round one 30 inches in diameter, is large enough. It should be about 36 inches in height for convenient handling of the die. The cold water coming into the tank through the nozzles and the heated water rising to the top and constantly passing out through the overflow pipe, eliminates the danger of overheating the water by continuous quenching, no matter how small the tank.

If a sufficient water supply is available, the pipe *C* should be 3 inches in diameter, the two branch pipes to the nozzles, 2 inches in diameter each, and the nozzle-mouths, 6 inches long by 1/2 inch wide. The overflow pipe *E* should be 4 inches in diameter. The water should be supplied to the nozzles at low pressure, preferably, to flow smoothly over the surface of the die. If the pressure is too high, the water will strike in spots and spatter off. Variations of this arrangement can be made to meet local conditions, but the general scheme should be followed.

Let us now assume that the die in the furnace is ready for quenching. First remove the packing box from the furnace, take off the cover, scoop the packing off the top of the die-block, and cut the wire that holds the cap on the face. Then lift the die out of the box, knock off the cap, and pass a wire brush over the face of the die to remove the surplus protecting paste. Do not bother about any that sticks on, as it will crack and fly off of itself the moment the cold water strikes it. Do not expose the die to the air longer than necessary, but get it into the quenching tank and under water as soon as possible by operating the tank as already described.

Do not let the die become stone-cold in the quench, but watch it carefully, and as soon as it has cooled sufficiently to permit of handling with the bare hands, remove it from the tank and put it into the tempering furnace *immediately*. This is very important, as severe cooling strains are locked into the mass of metal, and these forces, tending to pull it apart, are likely to cause cracking at any moment while it is exposed to the air. Experienced hardeners are well aware of this danger, and the writer has frequently seen them snatch a quenched die from the tank and go across the room on a dead run for the tempering furnace with it. Such speed is commendable, but it would be more to the point to place the tank near the tempering furnace.

Tempering the Die

There are two mediums in common use for tempering dies—the furnace and the oil bath. They are both good, but, personally, the writer favors the oil bath. It may be imagination on his part, but oil-drawn dies do seem tougher. The only drawback to the use of the oil bath is the odor. Whichever is used for tempering—the furnace or the bath—it should, of course, be heated to the full drawing temperature, ready to receive the die the moment it is taken from the tank.

Drawing temperatures range from 350 to 480 degrees F. At 350 degrees a perceptible "blush" appears on the surface of the steel; at 380 degrees the color starts; and at 480 degrees a full dark straw is attained. A temperature as low as 390 degrees can be used on small dies in light service; but for larger dies doing heavier work, temperatures of from 420 to 450 degrees are necessary. Large silver dies for use under heavy drop-hammers sometimes have to be drawn to as high a temperature as 480 degrees to avoid cracking, but this extra toughness is usually attained only at some sacrifice of surface hardness and wearing qualities. The nature of the work for which impression dies are used varies so greatly in different plants that it is impossible to give any set rules for their tempering. The above figures are given simply as a guide to experiment with under actual working conditions.

Give the die plenty of time in the tempering furnace or oil bath, so that the heat will penetrate to the very center and thus relieve the locked-in cool-

ing strains. Allow at least an hour for medium-sized dies, and an hour and a half for larger ones.

Do not quench the die when it is taken from the tempering furnace or bath, but place it in a slightly warm, dry place, free from drafts of air, and let it cool down of itself. Dry, warm sand is a good thing to set it down on for cooling. Above all, do not place it on a plate or other piece of cold iron.

The surface of a die hardened by this method will be as smooth and bright, and the delicate lines, edges, and corners as sharp and clean as when they left the die-cutter's hands, and there will be little or no warping in the longest dies.

Points to Remember in Hardening Dies

Use coarse crushed charcoal and coarse granulated bone for the packing; if these materials are too fine, they will cake around the die and offer too much resistance to the heat. For the same reason, do not tamp the packing down tightly around the die. Press it down well in the bottom of the box only, to support the weight of the die and pour the rest in around it loosely.

The packing mixture of equal parts of bone and charcoal should be used only when fresh burned bone—that is, bone that has been charred once in the furnace—is employed. Raw, or uncharred, bone has a greater carburizing action on the steel, so that if this is used, the packing mixture should be reduced to one-third bone and two-thirds charcoal to avoid danger of over-carburization of the die surface, with the results previously mentioned.

Don't use the hardening furnace to melt lead, babbitt, or any substance containing tin or lead. A few spatterings left in the furnace may cause "freckles" on the face of the dies. This phenomenon is known to some hardeners, but it is difficult to explain.

Don't temper even small dies by starting the color on a hot plate. This draws the immediate surface only and does not relieve the locked-in cooling strains, thus defeating the very purpose of the tempering. Nothing thicker than a safety-razor blade can be satisfactorily tempered in this manner.

Use a high enough quenching heat to obtain the greatest possible refinement of grain in the steel, as this means maximum depth, as well as surface hardness. Alloy steels will generally stand a higher heat than carbon steels. Determine the proper heat by hardening small pieces at varying temperatures and fracturing them. The temperature recommendations of the steel-makers are not always so specific as they might be, and the procedure indicated may aid in getting better results.

If a die cracks in service, it does not necessarily mean that the hardening was faulty. Frequently dies are not set true in the hammers or presses, and when the two halves do not register exactly, enormous strains are set up in operation, tending to crack them. The hardener has undoubtedly been unjustly blamed in many such cases. Check up carefully on the setting of all such dies. Also, in some instances, the cutting of the die is responsible for cracking prematurely in service, this being especially noticeable when the deeper lines are cut to a sharp V-shape at the bottom, as in some of the so-called "Colonial" patterns in silverware. Sterling silver, which has the characteristic of "flowing" freely under a heavy hammer blow, exerts a tremendous pressure on the sides of this V-shape depression, and tends to split the die apart.

Unusual Nut-Tapping Speeds

At a recent visit to the plant of the R. G. Haskins Co., Chicago, Ill., some unusually rapid nut-tapping was observed. For the last six months this company has tapped several million nuts as an experiment to determine the life of taps and to study the action of different types of cutting oils for tapping operations.

As an example of tapping speeds, the following figures are of interest: 3/8-inch by 24, slotted nuts, Class 4 fit, 48 nuts per minute; 5/16-inch by 24, plain nuts, Class 4 fit, 70 per minute; 5/16-inch by 24, castellated nuts, Class 4 fit, 65 per minute; 5/16-inch by 18, standard nuts, Class 3 fit, 67 per minute; 1/4-inch by 20, standard nuts, Class 3 fit, 94 per minute; and 1/4-inch by 28, standard nuts, Class 4 fit, 79 per minute.

All these nuts were tapped with standard taps, but the results were obtained by different methods of sharpening the taps from those generally in vogue, the new method of sharpening aiding materially in the results recorded.

The company has also been experimenting with various speeds to determine the critical speed for each size of tap. Most of the nuts are tapped at a speed of from 90 to 160 surface feet per minute. The simplicity of the design and operation of the machine used, which is fully automatic, makes tap breakages practically unknown. The life of a 1/4-inch by 20 tap averages 76,000 nuts, made from blanks cut from commercial bar stock. In one instance, one tap had a life of 140,000 nuts. The production between grinds averages between a minimum of 12,000 and a maximum of 20,000 nuts.

* * *

The Leipzig Fair remains the world's largest regular business exhibition. At the last fair, there were 6292 exhibitors, of which 662 were from twenty-three countries outside of Germany. It is of interest to note that in spite of changing political conditions, business depressions, and wars, the Leipzig Fair has been held continuously for the last seven hundred years.

The Machineability of Screw Machine Stock

By H. W. GRAHAM, General Metallurgist
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

IN the utilization of steel to provide the world with modern mechanical appliances, no greater advances have been made in machining practice during recent years than in the operations performed by the automatic screw machine. Screw machine builders, tool manufacturers, and producers of free-cutting steel have all contributed toward these advances.

What Takes Place in Cutting Metal?

As a background for studying the machineability of steels, it is necessary to understand what happens in cutting metal. In the first place, while the cutting edge of a tool may be said to be sharp when newly ground, the concentration of energy at the tool tip when the tool is placed in operation is so great that the cutting edge begins to round off very rapidly. This rounding off effect is apparent from the photomicrograph reproduced in Fig. 1, which is enlarged 100 times. The dark area indicates the point where the tool stopped cutting.

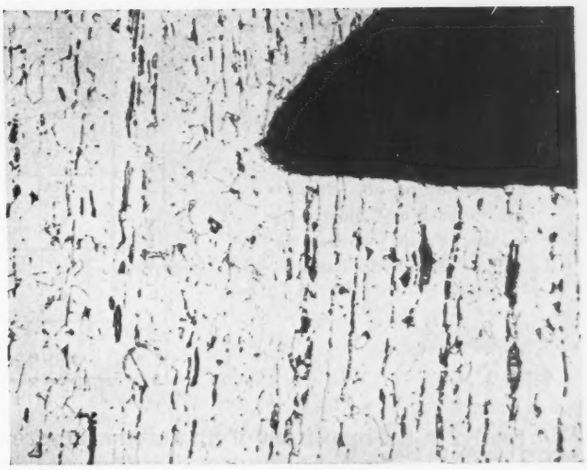
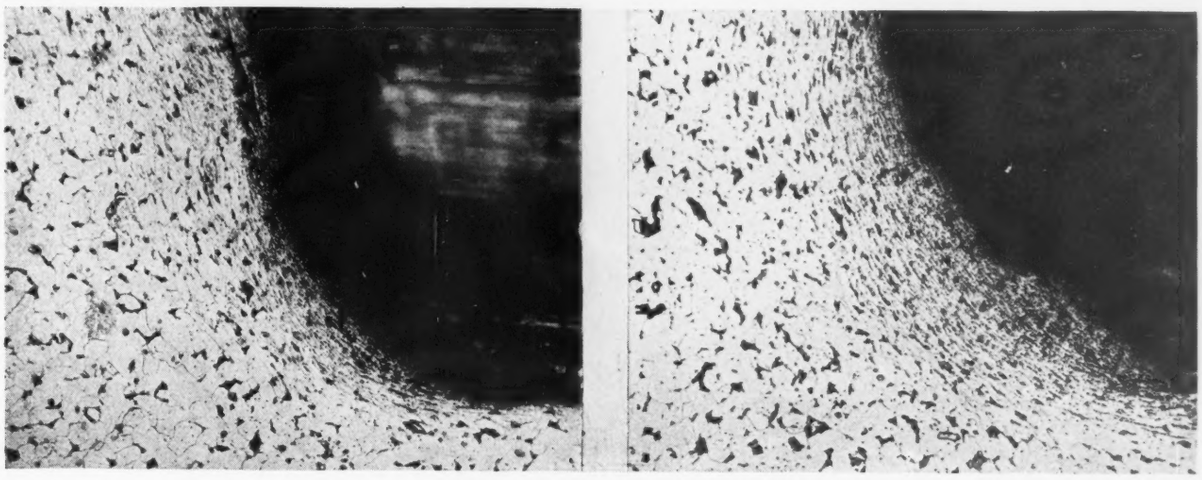


Fig. 1. Photomicrograph Showing how the Cutting Edge of a Tool Rounds off Appreciably within a Few Moments after it is Placed in Service

As the rounding of the cutting edge proceeds, the concentration of energy decreases, because the energy becomes distributed over a greater area of contact between the tool and the metal being cut. Finally, there is reached a condition of relative equilibrium of the energy dissipation, after which the rounding off of the tool tip proceeds very slowly, as indicated by the curve in Fig. 3, so that the tool will continue to cut satisfactorily for hours or even days. The rate of cutting edge rounding depends upon the resistance of the metal, the amount of metal being removed per second, the quality of the cutting tool, the kind of lubricant, and similar conditions. The initial rounding off probably takes place during the first few seconds—or at least minutes—of operation.

As the rounding off of the tool tip continues, a condition is finally reached where the energy becomes greater than can be dissipated with sufficient speed by the tool tip, and so the tool heats up rapidly and fails. This situation is represented by the right-hand end of the curve in Fig. 3.

Fig. 2. Photomicrographs Showing the Depth of Destroyed Metal ahead of the Tool in Cutting a Good Machining Steel (Left) and a Steel of Poorer Machining Quality (Right)



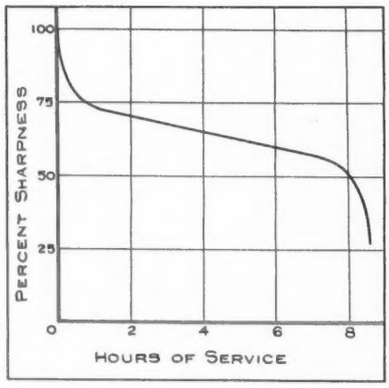


Fig. 3. Curve which Indicates that after the Initial Rounding off of a Tool Tip, the Rounding-off Process Continues Very Slowly up to the Point where the Tool Suddenly Fails

Normally, in the operation of an automatic screw machine, the somewhat round tool tip pushes its way into the steel and causes destruction, by compression, of a small area of the natural structure ahead of the tool. This destroyed metal pushes or pries off the remainder of the chip.

How the Metal Ahead of the Tool is Affected

The photomicrographs in Fig. 2 show a thin layer of steel ahead of the tool in which the natural structure has been destroyed. (The dark areas represent the points where the tool stopped cutting.) Just beyond this layer, there is a considerably larger area that has been appreciably distorted. The remainder of the steel structure is normal and unaffected.

In general, good machineability is to be associated with a minimum of distorted or destroyed structure, as in the case of the left-hand photomicrograph in Fig. 2. The right-hand photomicrograph shows a greater depth of distorted metal—it indicates a steel of poorer machining quality. Obviously, if a chip of given size can be removed by distorting and destroying only a small volume of metal, less energy is required than if a greater volume must be distorted and destroyed. Also, the lesser energy required for distorting or destroying a smaller volume of structure will be associated with longer tool life or increased speed of operation, or both. This general condition may be restated by saying that machining quality is proportional to the depth of penetration of the force exerted at the tool tip.

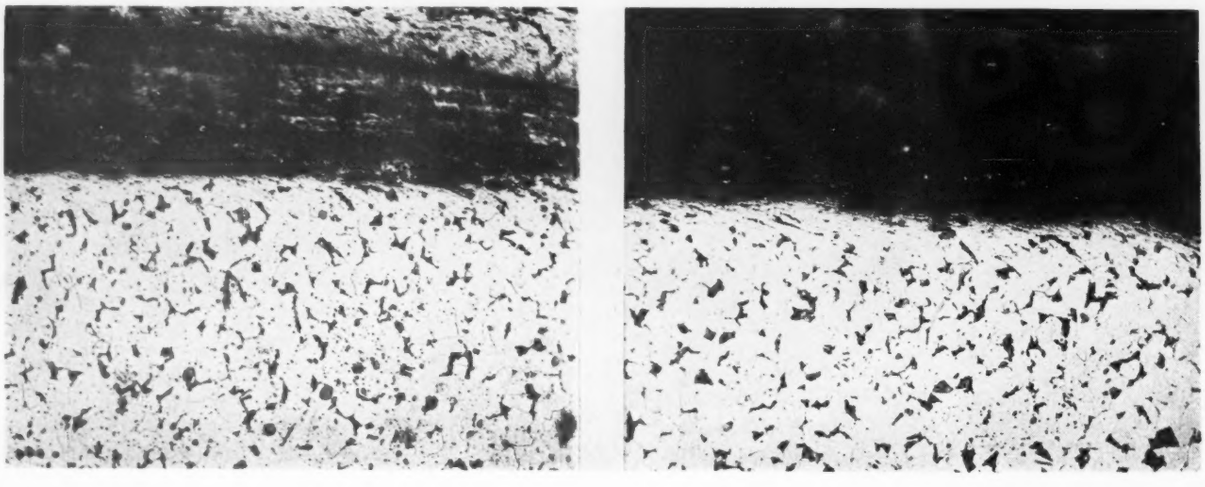
By examining the photomicrographs shown in Fig. 4, it can be seen that the finished surface varies somewhat with the machineability of the steel. In these photomicrographs, the dark areas represent the path of the tool as it cut a groove in the metal. On the specimen of poor machining steel, at the right, there will be seen a thin but still existent layer of totally destroyed structure, and beneath that, an appreciable layer of distorted structure. On the good machining specimen, at the left, there is practically no totally destroyed structure and the layer of distorted structure is very much thinner.

Furthermore, it can be seen that the contour of the poor machining specimen is much more irregular than that of the good machining sample. It is therefore evident that smoothness of finish is definitely tied in with the energy requirements of the cutting operation. Both photomicrographs are magnified 100 times.

Production Depends upon Life of Tool between Grindings

The number of parts produced by an automatic screw machine per week of operation is pretty definitely a function of the length of time between tool grindings. If the machine were run at extremely low speed, it might be possible to get along by grinding the tools only once a week, but the number of parts produced would be very small. At the other

Fig. 4. Photomicrographs Showing the Comparative Surface Finish of a Good Machining Steel (Left) and of a Poorer Machining Quality (Right)



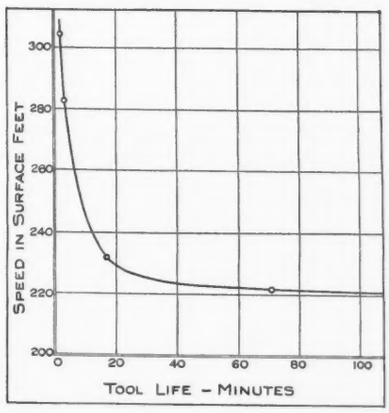


Fig. 5. Chart Showing the Direct Relationship between the Speed of the Work and the Life of the Tool

extreme, if the machine were operated so fast that tools lasted only forty minutes, and if twenty minutes was required for tool grinding, the number of finished parts produced per week would again be very small, due to the large amount of "down" time, in spite of the high rate of production during the actual operation.

By experience, the shop superintendent usually finds that a certain rate of operation necessitates regrinding the tools only once each half day or once each day. One of these two rates is generally selected.

There is a critical point in the relationship of work speed and tool life for every heat of steel. The location of this critical point varies from one heat to another. The diagram Fig. 5 illustrates the relationship of tool life and work speed. It indicates that for the particular lot of steel under observation when the curve was charted, the critical point was about 230 surface feet per minute. The shape of the curve suggests that at 10 per cent below the critical point (about 210 surface feet per minute) the tool should last for days between grindings.

The length of time that a tool will operate between grindings depends upon the spindle speed, the feed, and the depth of cut. In other words, it depends upon the amount of metal removed per unit of time, or in still other words, upon the rate of power or energy required.

One steel may be of better machining quality than another at a given feed and depth of cut, but with a different feed and depth of cut, the second steel may prove to be better than the first. Generally, at a given speed, if the feed and depth of cut are light, Bessemer screw steel machines much better than open-hearth screw steel, but the difference decreases sharply as the feed and depth of cut are increased. Under some conditions, certain open-hearth grades even excel Bessemer screw steel in performance.

This condition is shown by the diagram Fig. 6. It is interesting to note that the tool life, with open-hearth grades, is almost independent of the amount of metal removed. This means that the feed can be increased on open-hearth screw steel with little or no sacrifice of tool life. In this way, production can be increased at practically no cost.

The same diagram shows the comparative machineability of representative heats of various grades of screw steels, with the addition of one heat of SAE 1020. The data on which this chart is constructed were obtained by operating a commercial type of four-spindle automatic at a speed of 220 surface feet per minute under carefully controlled test conditions in the Jones & Laughlin laboratory. The chart clearly shows that it is unwise to attempt to set up a table of comparative machineability of various grades of steel, because of the fact that the relative performance varies so greatly with the amount of metal removed.

* * *

The Bolinder Mechanical Works, of Stockholm, has introduced a new type of Diesel engine embodying some important, novel features, both as regards its outward appearance and general design. The chief engine designer of the concern, R. A. de Waern, has been busy for some time trying to solve the problem of designing a two-stroke engine, conforming in principle to the modern Diesel type, yet better, and answering the needs of the heavy-duty as well as light weight crude oil engines of today. Judging from practical tests on a British motor tug, in which the new engine has been fitted, it shows every evidence of becoming a valuable asset to marine transportation.

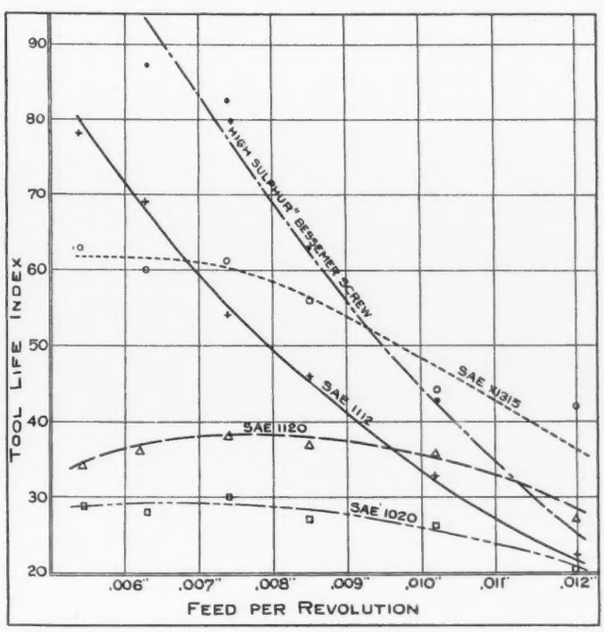


Fig. 6. A Chart that Shows the Difficulty of Establishing a Table of Comparative Machineability of Various Steels, on Account of the Fact that the Performance Differs Greatly with the Amount of Metal Removed

The Trend in Metal-Cutting Materials

A Committee of the American Society of Mechanical Engineers Makes a Comprehensive Survey that Gives Much Information on Present-Day Cutting Tools

Prepared for the Committee by R. C. DEALE

THE Subcommittee on Metal-cutting Data, recently organized under the procedure of the American Society of Mechanical Engineers, with King Hathaway as chairman and R. C. Deale as secretary, has engaged in a far-reaching program for obtaining authoritative information on all phases of metal-cutting. Industry has already given the committee a large measure of cooperation, and it is expected that as the work of the committee proceeds, it will have the thorough support of leading industrial firms.

In the collection of data on metal-cutting tools and their use, it was deemed advisable first to obtain data on metal-cutting materials now in use, the relative amount of each used, and any tendencies toward a change in metal-cutting tools. Inquiries were directed to forty-four manufacturers of tool steels and one hundred and four typical machine shops.

Summary of the Opinions of Steel Manufacturers

All the manufacturers of tool steel who replied to the questionnaire believe that the standard 18 per cent tungsten, 4 per cent chromium, 1 per cent vanadium, and the 14 per cent tungsten, 4 per cent chromium, 2 per cent vanadium steels constitute the bulk of present-day demand—probably 65 per cent. One company expresses the belief that the so-called "super-high-speed steels" will ultimately be eliminated, and that all work will be done with standard high-speed tools or tools of the carbide type.

The information obtained indicates that the relative use of cobalt steels is increasing, although this class of steel does not make up a very large proportion of the total. There appears to be a general agreement that cobalt and other super-high-speed steels are used for from 2 to 5 per cent of the machining in the country. Steels containing cobalt are recommended for turning hard materials. Such steels, after being hardened, usually have a soft skin of unhardened metal from 1/32 to 1/16 inch in depth over their whole surface, but it is not known whether this effect is caused by a surface decarburization or by some other metallurgical change. In any event, the effect of this has been to make it inadvisable to employ such steels for tools that are formed before hardening, such as formed milling cutters, taps, drills, etc., although it is entirely satisfactory for such tools as lathe and planer tools, where this soft skin can be ground away after the tool has been hardened.

The production data given by one company indicate a marked increase in the sales of cobalt steels from 1929 to 1932, while the demand for standard steels dropped. Two other companies have remarked a somewhat similar trend, but are disposed to discount its effect because of the generally low volume of sales during the last two years.

One company notes appreciably longer life between grinds with high-vanadium tools, provided the carbon content is increased at the same time as the percentage of vanadium.

Consensus of Opinion of Cutting-Tool Users

A very large number of the machine shops approached for information returned the questionnaires with the required data. Of those who answered, 70 per cent use tungsten- or tantalum-carbide tools to some extent, but most of them in very small percentages. Taking all sources of information into consideration, it is believed that the following table substantially represents the relative percentages of cutting-tool materials used for machining operations in the United States:

Tool Material	Approximate Percentage of Use
Carbon Steel	15
18–4–1 High-speed Steel	65
14–4–2 High-speed Steel	11
Cobalt High-speed Steels	4
Stellite	3
Tungsten and Tantalum Carbide	2

It is interesting to note that the companies that use cobalt steel or Stellite generally use it for a large percentage of their work. It is believed that such companies have taken steps to insure that they obtain the maximum production of which these tools are capable, and, hence, find it advantageous to make use of these cutting materials for many operations. Several particularly well managed companies appear to be using Stellite and cobalt steel for approximately 90 per cent of the work on which such tools can be used. Carbide tools are used for the balance of the work. Two machine tool companies are using carbide tools for approximately 70 per cent of the work for which such tools can be used.

The automotive and machine tool industries use cobalt and carbide tools to a much greater extent than the other groups of the industry. In the heavy machinery group, the companies making extensive use of the newer cutting materials have either made recent changes in their general shop methods or have unusually progressive managements. As a rule, however, the greater number of manufacturers of heavy machinery use standard-analysis

steel for practically all their work; the same is generally true of the railroad shops.

In the case of shops manufacturing small parts on a repetitive basis, such as the typewriter factories, the permissible machining speeds appear to limit the speed of cutting, rather than the capacity of the tool. In these shops, a considerable number of carbon-steel tools are used.

A great many companies report experiments with carbide tools and expect to extend their application as business improves. It is of interest to note that the two machine tool companies who make the greatest use of carbide tools have also featured the ability of the machines that they build to run at the higher speeds which carbide tools require for economical operation.

An Amazing Photographic Research in Metal-Cutting

Photographic exposures as fast as one millionth of a second have been made in a remarkable research recently conducted in Germany to determine what actually happens in metal-cutting. By making exposures so unbelievably fast, it has been possible to obtain pictures of metal chips while they were being formed, even with the work revolving at surface speeds greater than 3000 feet a minute. The total exposure time in making over 1200 pictures was less than 0.001 second. These photographs have upset some long established theories on metal-cutting.

The method and equipment used in this investigation were described in a paper presented at the meeting of the American Society of Mechanical Engineers held at the Century of Progress Exposition in Chicago by Professor Friedrich Schwerd of the Technische Hochschule, Hanover, Germany. It was later read before a second group at the Museum of Science and Industry in New York City.

Special equipment was, of course, necessary for this investigation. Electric sparks that created sufficient light for the exposures were produced by condensers which give instantaneous currents of from 10,000 to 20,000 amperes. Two kinds of pictures were taken: First, instantaneous pictures which showed the formation of the chips at a greatly enlarged scale. These pictures were enlarged by the camera from five to ten times, and then enlarged another five times while being printed, so that the enlargements were from twenty-five to fifty times. The photographs are remarkably sharp and distinct. Second, motion pictures were taken consisting of a series of instantaneous pictures which permit the study of a complete cycle of chip formation from one break to the next. A straight cutting tool of tungsten carbide was used in a heavy lathe for the investigation, the cut being taken on a disk with the cutting edge of the tool parallel with the axis of the work.

The photographs show that very low cutting speeds usually result in shearing chips and high speeds result in flowing chips. Tearing chips are formed in the case of brittle materials, such as cast iron, the chips coming loose with a sort of bursting of the material.

The forming of "built-up edges" on tools was examined in detail. It was proved that the built-up edge, contrary to general opinion, does not occur at high speeds. Also, the built-up edge changes its size in periods of a few thousandths of a second. The pile grows by the continuous accumulation of new scale. This pile penetrates into the work, the pressure deforming the work surface.

At the slower cutting speeds, the pile periodically wastes away, groups of the flakes being broken off by the chip, and portions also being carried away by the cylindrical surface of the work. At higher cutting speeds, wasting away occurs by the periodic carrying away of the entire pile by the chip.

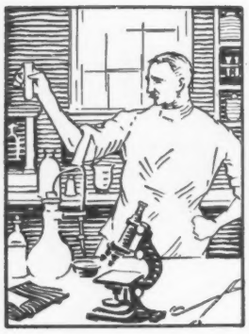
Whenever a built-up edge occurs, the surface of the work is distorted. At the lower cutting speeds, irregular scales occur on the surface; with medium speeds, there are alternately rough and smooth portions corresponding to the change in size of the built-up edge; and with high cutting speeds, at which no built-up edges are formed, smooth surfaces are obtained on the work. In cutting brittle materials, there is usually a preliminary cleavage of the chip from the work without the formation of a built-up edge, as was indicated by the pictures taken in cutting cast iron and cast aluminum. A built-up edge, however, may also occur with these metals.

* * *

Steel Beer Barrels Thoroughly Cleaned by Sand-Blasting

The Pangborn Corporation, Hagerstown, Md., has recently developed three sand-blasting machines for thoroughly cleaning the inside of beer barrels ready for the enameling or other finishing application which protects and conserves the beverage, and the outside of the barrels ready for a rust-resisting coat. The machine that sand-blasts the outside of the barrels has a capacity of fifty barrels an hour. The cleaned barrels are dropped automatically from the machine and new barrels loaded into place.

The second machine is designed for cleaning the inside of complete barrels at the rate of from thirty to one hundred barrels an hour. The third machine is also designed for cleaning the interior of barrels, but this is done while the steel shells are in two parts. When the cleaning has been completed, the two pieces are welded into one shell.



MATERIALS OF INDUSTRY

PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

White-Metal Bearing Alloys with Cadmium and Tin

A paper presented before the American Society for Testing Materials in Chicago by C. E. Swartz and A. J. Phillips, of the American Smelting and Refining Co., compared white-metal bearing alloys containing tin with those containing cadmium at temperatures up to 300 degrees C. (572 degrees F.). It was pointed out that the compressive strength of cadmium-nickel bearing alloys is greater at all temperatures than that of tin-base babbitts and that the softening point is higher.

A test was described in which a six-cylinder automobile having three connecting-rods equipped with unbacked cadmium bearings and three fitted with tin-base babbitt, bronze-backed bearings was run 62,500 miles. At the end of this run, the tin-base bearings had melted while the cadmium bearings were suitable for additional service.

It is interesting to note that cadmium is found in the United States, whereas tin alloy must be imported.

Remarkable Properties of Cromansil Steels

Silicon and silicon-manganese low-alloy steels have recently been developed for the purpose of obtaining a high-strength low-alloy steel that can be applied where it would not be economical to use other types of alloy steel. Small additions of chromium to silicon-manganese steels have been found to greatly improve their physical properties. Hence, a series of low-alloy steels known as Cromansil steels have been developed for various structural and engineering purposes. The term Cromansil is used to indicate all steels within the range of alloy content used, and does not designate any particular alloy steel.

The composition of these steels varies according to the purposes for which they are made. The grades most widely used contain from 0.4 to 0.6 per cent chromium, from 1.1 to 1.4 per cent manganese, from 0.7 to 0.9 per cent silicon, and from 0.10 to 0.65 per cent carbon. This steel, in the "as-rolled" condition, has higher strength than any type of plain carbon steel. Tensile strengths from 80,000 to 100,000 pounds per square inch can be expected ordinarily, but tests have shown a strength of 140,000 pounds per square inch, and by heat-treatment, the ultimate strength has been raised to 170,000 pounds per square inch. Great ductility is another property of this steel. It has also a high fatigue limit and high impact strength.

This material can be rolled into standard structural shapes and can be machined, punched and sheared, pierced and drawn, cut by the oxy-acetylene process, welded, and otherwise fabricated without any essential variation from usual manufacturing practice.

The toughness and ductility of this type of steel has led to its extensive use for seamless tubing. Over 2,000,000 feet of Cromansil steel oil-well casing has been used with satisfactory results. It is well adapted for pressure vessels, and in the structural field, for bridges, buildings, penstocks, and ship plates.

The Growing Use of Alloy Steel Castings

It has been estimated that, in 1921, only 4 per cent of all steel castings produced were of the alloy type. In 1931, the percentage had increased to 17. Present indications point to still further growth in the use of alloy cast steels.

Wire and Wire Products Made of Allegheny Metal

Arrangements have been concluded by means of which the American Chain Co. and associate companies will take over the drawing, fabricating, and sale of Allegheny metal and other Allegheny alloys in round, flat, and shaped wire forms.

This new wire will be marketed by the Page Steel & Wire Co., Monessen, Pa. The same company will also fabricate welding wires, farm fence, barbed wire, and other products.

Various forms of wire rope will be made from the alloys by the Hazard Wire Rope Co., Wilkes Barre, Pa. Chains and chain attachments will be produced at the York, Pa., plant of the American Chain Co.

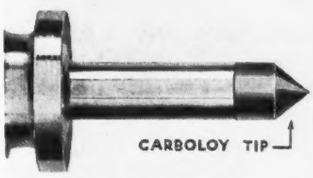
Elevated Railroad Trains Made of Aluminum

The New York Rapid Transit Corporation has awarded the Pullman Car & Mfg. Corporation a contract for the construction of a revolutionary type of elevated railroad train, to be placed in service in Brooklyn for experimental use on elevated and subway lines. The train will consist of a five-car unit mounted on six trucks, the four middle trucks carrying the adjoining ends of two cars. As typical of New York City transportation, the train will have a seating capacity for 210 passengers and standing capacity for 458. Both car bodies and trucks will be made from aluminum alloys, with the exception of the wheels, axles, springs, and similar parts. The weight of the entire train will be 130,000 pounds—about one-half that of present trains with similar passenger capacity. Despite the light weight, there will be no sacrifice in strength. The safety factor for passengers will actually be greater than in the present trains.

Carboloy Increases the Life of Valve Stems and Seats

Valve stems and their seats in hydraulic presses, pumps, rams, and similar equipment are subjected to such high abrasion and pressure that frequent replacements are necessary to insure accurate control of the pressure.

With a view to reducing maintenance costs on these parts, Carboloy cemented tungsten carbide has been applied in the form of inserts by the Carboloy Co., Inc., Detroit, Mich. The illustration shows a Carboloy tip brazed on a valve stem, the tungsten carbide replacing the steel at the point only. On a valve seat a ring of Carboloy occupies the section with which the valve stem comes in contact. Sufficient material is provided for regrinding the parts as required.



A Carboloy Point Increases the Life of Hydraulic Valve Stems

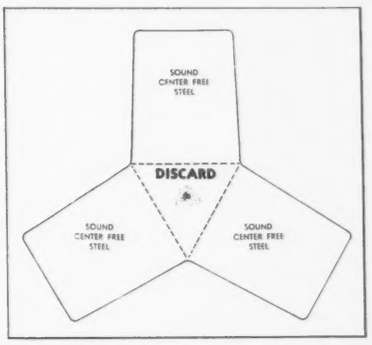
The inserts possess the high degree of hardness and compressive strength necessary to withstand the abrasion and pressure met with in the operation of hydraulic valve stems and seats.

Better Bearing Metals Needed for Newer Type Engines

Demands for increased power of internal combustion engines have forced the development of better bearing metals. These developments have been mainly along two lines—improvements in tin-base babbitt metal and the development of copper-lead mixtures. According to J. B. Fisher, chief engineer of the Waukesha Motor Co., as stated in a paper read before the Chicago Section of the Society of Automotive Engineers, copper-lead bearings will carry higher loads than the tin-base babbitt metals, especially at high temperatures. The strength of copper-lead mixtures is about 20,000 pounds per square inch and their melting point about 1700 degrees F.

A New Method of Casting Center-Free Ingots

A method of casting steel ingots that results in a uniform center structure of high quality in the finished bar has been developed by the Firth-Sterling Steel Co., McKeesport, Pa. The method involves the use of a patented three-winged ingot mold which makes it possible to discard the entire center of the ingot where porosity, inclusions, gases, segregations, and other impurities exist.



Sketch of Winged Ingot, Showing the Sound Ends and the Discarded Center

These impurities ordinarily occur in the center of a rectangular ingot. In the winged ingot, they are in the triangular center, which is scrapped after the sound wings have been cut off for manufacture into finished products.

Although this process has just been announced to the trade, the Firth-Sterling Steel Co. in the past has produced hundreds of tons of sound "center free" tool and die steels by this method.

Tanks of Stainless Clad Steel Solve a Brewing Problem

Three huge tanks for the storage of beer have recently been installed in the brewery of the Prima Co., Chicago, Ill. These tanks were made of Ingo-clad stainless clad steel, because this material has proved to be entirely non-toxic to beer. Also, it does not discolor or corrode.

Each tank has a capacity of 150 barrels and measures approximately 8 1/2 feet in diameter by 12 feet long. The tanks were made by the Ingersoll Steel & Disc Co., also of Chicago, from stainless clad steel with a 20 per cent thickness of 18-8 chrome-nickel steel on ordinary steel plate. The total thickness of the material used for the cylindrical portion of the tank is 1/4 inch, and for the bell-shaped heads, 5/16 inch.

Chromium Steel Castings of Unusually High Strength

In a paper presented before the American Foundrymen's Association in Chicago by J. H. Critchett, vice-president of the Union Carbide & Carbon Research Laboratories, Long Island City, N. Y., attention was directed to a new development in the production of steel castings—the introduction of nitrogen in steels containing over 20 per cent chromium. Nitrogen is added by means of a high-nitrogen ferro-chrome. It must be present in the final steel to the extent of one part to every one hundred parts of chromium.

Materially increased strength and toughness, with only a slight increase in the hardness, are the advantages obtained. The addition of nitrogen is said to have no detrimental effect on the machineability of the castings. The important advantage lies in the greatly decreased grain size of the metal, which gives increased toughness.

It was stated that a 24 per cent chromium steel with a nitrogen content of 0.22 per cent has an ultimate tensile strength of 106,000 pounds per square inch, a yield point of 71,000 pounds per square inch, an elongation of 12 per cent and a reduction in area of 12 per cent. A steel of similar composition, except for the nitrogen content, which is only 0.05 per cent, has a tensile strength of 84,000 pounds per square inch, a yield point of 52,000 pounds per square inch, an elongation of 7 per cent, and a reduction in area of 7 per cent.

Oil-Proof Rubber Promises to Meet Many Problems in Industry

The development of an oil-proof rubber promising great possibilities to industry was referred to at a recent meeting of the American Chemical Society by Dr. W. L. White of Raybestos-Manhattan, Inc., who described the product as "fulfilling the rubber man's dream of an oil-proof rubber." Dr. White stated that twenty years of research have been devoted to the discovery of a rubber product that would be resistant to most chemical solvents.

Experiments with a rubber-like product known as "Thiokol" (made by the Thiokol Corporation, Yardville, N. J.) have made it possible to obtain a material that is resistant to gasoline, kerosene, toluol, and mineral oils of all kinds. Vegetable oils, such as cotton-seed and linseed oil, and fats, such as stearic and oleic acids, affect it but little; nor is it much affected by solvents such as alcohol, ether, and carbon tetrachloride. Turpentine will soften it slightly on the surface, but, on the whole, the material resists the action of this solvent. It is, however, affected by carbon disulphide and strong alkalies, but has a fair degree of resistance to most of the common acids and weak alkalies.

On the other hand, it has some disadvantages. It has an unpleasant odor. It is affected to a marked degree by both high and low temperatures. If heated above 150 degrees F., it becomes quite soft—too soft for most commercial uses. At temperatures 10 degrees F. below zero and lower, it becomes very stiff—almost brittle. It does not have as good "non-cold" flow properties as ordinary rubber and should not be subjected to too heavy a load. Its tensile strength and its elongation value are low, and it is not highly resistant to abrasion, but it can be bonded to ordinary rubber and is very useful as a protection and covering. As a solvent resistant, however, the new material gives excellent service.

Experiments have been made recently with a new material in the same field known as "DuPrene" (made by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). This material has a good tensile strength, good elongation, and shows a high wear resistance. It is more heat-resistant than rubber, and this property may provide for DuPrene an entirely new field of usefulness, aside from its resistance to solvents. It resists gasoline, kerosene, and light oils better than rubber, but not so well as Thiokol. It should not, however, be subjected to the action of benzol, toluol, xylol, and similar solvents. The two new materials appear to supplement each other nicely; each has its distinct fields, and together they go a long way in meeting the demands for a solvent-proof rubber.

Beryllium-Copper Castings for Airplane Propeller Bearings

Beryllium-copper castings are so recent a development that not many applications have yet been made. However, many uses were prophesied for these castings in a paper read by Edwin F. Cone before the American Foundrymen's Association in Chicago, because of the properties that can be developed by heat-treatment.

An interesting application in the field of aviation is a 2.50-per cent beryllium-copper casting used as an intermediate sleeve between the driving shaft and an adjustable-pitch propeller. This sleeve must provide a satisfactory bearing for the two parts, and a great deal of research was necessary before a non-ferrous material was found that was hard enough to function without sticking or scuffing.

Hardened beryllium-copper castings have been found to possess the desired properties. These sleeve castings are made by the American Manganese Bronze Co., Holmesburg, Philadelphia, Pa. While the usual practice is to machine beryllium-copper castings in the annealed or quenched (soft) state and then harden them, a study of the manufacturing process in this particular instance showed that it was cheaper and more satisfactory to heat-treat first and do all the machining after the final hardening. This indicates that there is no difficulty in machining beryllium-copper castings in the finished condition when they have a Brinell hardness of about 400. Racing boat propellers, cams for machinery, and gears and pinions cast from beryllium copper have also proved satisfactory in service.

Variable Speed with Vacuum Tubes

A synchronous motor operating efficiently at variable speeds by means of a new type vacuum tube control was recently demonstrated in the General Electric test laboratories at Schenectady. The new control, a development of Dr. E. F. W. Alexanderson, consulting engineer of the company, has many important uses in the electrical industry when it is desired to operate alternating-current motors at various speeds with remote control. An important field promises to be the electric ship. Steam turbines operate most efficiently at full speed. To slow down the propeller motors, it is necessary to slow down the turbines. With the new equipment, the turbine operates at one speed constantly, and the speed of the propeller motors can be varied by changing the frequency of the current fed to them through the vacuum tube control. Instead of the captain communicating orders to the engine room for a change in speed, the new apparatus makes it possible for him to regulate the speed of the driving motors directly from the bridge. The motor demonstrated was 400 horsepower, and the efficiency of the frequency converter 98 1/2 per cent.

* * *

Boring, Drilling, and Facing Fifteen Refrigerator Units per Hour

In Fig. 1 is shown a one-way horizontal Natco boring and facing machine built by the National Automatic Tool Co., Richmond, Ind., which machine is arranged with a semi-automatic hydraulic feed. With this arrangement, the operator has complete control of the machine through the operation of one air valve. The four-position, sliding-type fixture with which this machine is equipped holds a single part and is arranged to accommodate the three sizes of cast-iron refrigerator crankcases shown in Fig. 2.

Fig. 2. Three Sizes of Cast-iron Refrigerator Crankcases Machined on Equipment Shown in Fig. 1

The operation performed at the first position on the largest of the three crankcases consists of boring a 3 15/16-inch hole and core-drilling a 1 3/8-inch hole. The tolerance on the larger hole is 0.002 inch, and on the smaller hole, 0.019 inch. In the second position, the two holes machined in the previous operation are semi-finish-bored and chamfered. In the third position, the larger hole is finish-bored and the smaller hole is reamed. In the fourth position, the 5 7/8-inch boss and the 2 1/4-inch boss are faced, the head being located against a positive stop. Similar operations are performed on the two smaller crankcases.

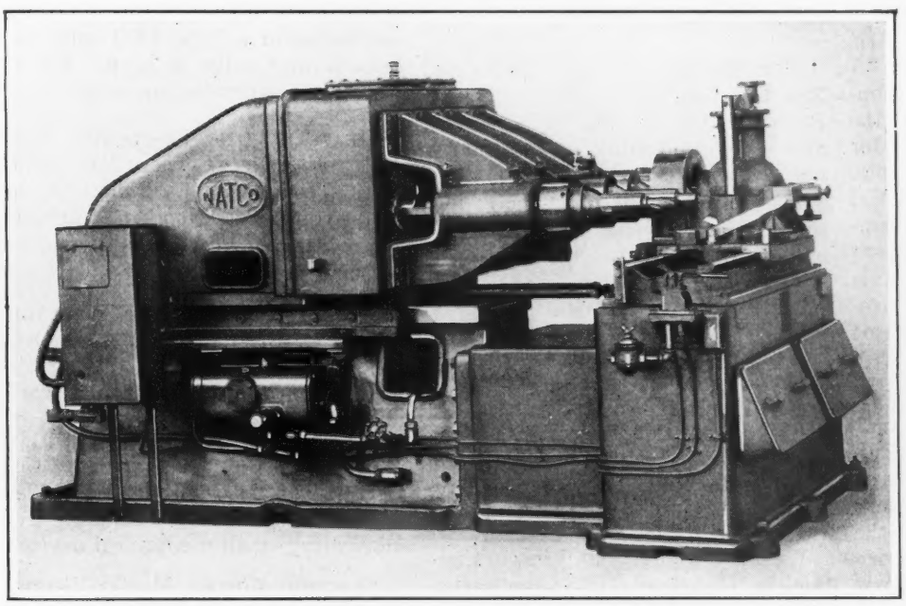


Fig. 1. Natco Boring and Facing Machine with Fixed-center, Gear-driven, Cluster Box Containing Four Spindles Mounted in Heavy-duty Roller Bearings

* * *

Removing Broken Studs

According to *Oxy-Acetylene Tips*, broken studs can easily be removed by building up 1/2 inch or more of metal above the surface level to which the studs have broken off, by means of the welding process. A blowpipe flame and steel welding rod will quickly do this work. After the steel has cooled off to room temperature, the stud can be removed easily with a pipe wrench. In one instance, this method has been applied successfully to studs from 1/4 inch to 1 1/2 inches in diameter.

NEW TRADE LITERATURE

Any of these Publications can be Obtained by Writing to the Manufacturer or to MACHINERY. Send for Your Copy Today.

GRINDING WHEELS AND ABRASIVE MATERIALS. Carborundum Co., Niagara Falls, N. Y. Booklet treating of the subject of modern roll grinding practice. Those who are interested in this class of work will find a fund of technical information available here. An idea of the scope will be obtained from a partial list of the subjects covered: Relation of surface to finish; wheels for obtaining a good surface; types and characteristics of rolls; problems introduced by roll-grinding machines; methods of roll mounting; lubrication of rests during grinding; roll speeds; coolants and filters; wheel selection; factors affecting good grinding; instructions for grinding a variety of rolls for different classes of work.

NICKEL ALLOY STEELS. International Nickel Co., Inc., 67 Wall St., New York City, is distributing a circular chart which shows at a glance the nickel alloy steel compositions and heat-treatments required to develop yield points up to 175,000 pounds per square inch in section sizes varying from 1 to 12 inches. The figures given are based on numerous tests and can be used as a general guide in the selection of steels for bars, shafting, and forgings of simple shape.

PLASTICS. Boonton Molding Co., Boonton, N. J. Booklet entitled "A Ready Reference for Plastics," containing a brief description of the commonly used plastics, compiled for the guidance of engineers and buyers. The specific mechanical and electrical properties of nine of the most common types of plastics are given, as well as the field for which each is especially adapted. A section of useful tables is included at the end of the book.

LABORATORY APPARATUS AND MICROSCOPICAL SUPPLIES. E. Leitz, Inc., 60 E. 10th St., New York City. Bulletin 8, descriptive of the Leitz new chemical microscope for laboratory work. Bulletin 9, descriptive of the Leitz wide-field binocular microscopes for use in metallurgical work, general engineering work, such as testing tools, etc., and industrial laboratories.

PRECISION LEVELS. Universal Boring Machine Co., Hudson, Mass. Circular illustrating and describing the Universal precision level designed for use in erecting and aligning machinery. The bubble in the vial of this level has a sensitivity of 5 seconds per graduation. This is equivalent to showing per graduation on the vial a variation of 0.00029 inch per foot.

TUMBLING AND BURNISHING EQUIPMENT. Magnus Chemical Co., Garwood, N. J. Booklet entitled "Tumbling, Rolling, and Barrel Burnishing," by R. W. Mitchell, technical director of the company. The book contains a number of profusely illustrated chapters on the subject dealt with, covering it in a thorough manner.

ELECTRIC EQUIPMENT. General Electric Co., Schenectady, N. Y. Bulletins GEA 1746, 1755, 1761, and 1765, dealing, respectively, with Glyptal-cloth insulated cable; CR7505-K1 photo-electric relay; motor-starting switches for fractional-horsepower motors; and fractional-horsepower gear-motors.

ALLOY STEEL CASTINGS. Lebanon Steel Foundry Co., Lebanon, Pa. Pamphlet describing this company's line of Circle "L" alloy steel castings for high stresses and wear resistance, and Circle "L" stainless alloy steel castings for corrosion- and heat-resistance.

WELDING EQUIPMENT. Lincoln Electric Co., Cleveland, Ohio. Application Sheet No. 34 in a series on the Elements of Design, dealing with the application of arc welding in the design of wheels, including gear blanks, conveyance wheels, flywheels, and pulleys.

BELTING. L. H. Gilmer Co., Tacony, Philadelphia, Pa., is issuing a publication known as *The Gilmer Arc of Contact*, describing various applications of Gilmer belting, and containing other general information for belt users.

CONVEYOR CHAIN. Whitney Mfg. Co., Hartford, Conn. Bulletin V-109, containing complete information on Whitney conveyor chain of the roller type described in the Shop Equipment Section of this number of MACHINERY.

SHEAR KNIVES. Niagara Machine & Tool Works, 637-697 Northland Ave., Buffalo, N. Y. Circular announcing special high-speed steel knives for Niagara shears, as well as a regrinding service for shear knives.

SYNTHETIC PLASTIC PRODUCTS. Bakelite Corporation, 247 Park Ave., New York City. Booklet entitled "The Versatile Service of Bakelite Resinoid," containing concise information on Bakelite products.

ELECTRIC EQUIPMENT. Roller-Smith Co., 233 Broadway, New York City. Advance price sheet for new test set consisting of a Type CSO split core transformer with a Type PA or "Steel-Six" portable ammeter.

HEAT-TREATING FURNACES. Ajax Electrothermic Corporation, Ajax Park, Trenton, N. J. Bulletin 8, descriptive of Ajax-Northrup furnaces for melting or heat-treating, and accessory equipment.

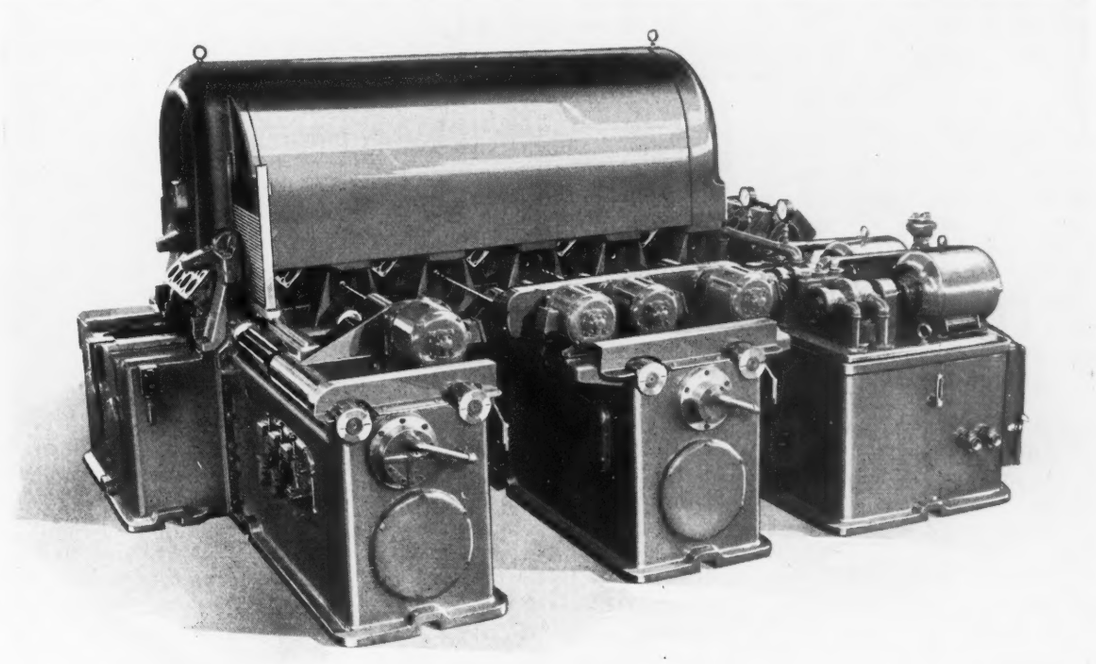
BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Loose-leaf sheet No. 203 FE, illustrating the application of ball bearings in variable-stroke hydraulic pumps.

GRAPHITE. Acheson Oildag Co., Port Huron, Mich. Bulletin M102.4, dealing with colloidal graphite for lubricating small mechanical devices.

ELECTRIC MOTORS. Master Electric Co., Dayton, Ohio. Folder illustrating and describing newly added facilities to the company's plant.

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts and Material-Handling Appliances Recently Placed on the Market



Hammond Hydraulic Drilling, Reaming and Tube-Inserting Machine

Hydraulic equipment was recently built by the Hammond Mfg. Co., 3089 E. 80th St., Cleveland, Ohio, for drilling and reaming V-type automobile cylinder blocks to receive a main-bearing oil-tube and for assembling this tube, all in one operation. A conveyor brings the cylinder blocks to the right-hand end of the machine, as seen in the heading illustration, from which point they are successively carried to the six stations of the machine. At the left in Fig. 1 is shown a cylinder block before the operation, and at the right, a block with an oil-tube *A* in place.

At the first station of the machine a hydraulically operated transfer mechanism receives the cylinder block for indexing it through the machine. At the second, third, and fourth stations, holes are drilled through three bosses, and at the fifth station all three holes are line-reamed to different diameters. At the sixth station, the oil-tube is automatically taken from the magazine near the left-hand end of the machine and pressed into place. A total pressure of 9600 pounds is applied at this step.

At each station, locating dowels are inserted into the cylinder block and clamps are lowered to hold the block in position. At Stations 3 and 4, bushings are lowered into the casting to guide the drills as they enter the bosses. All operations are performed hydraulically, the working pressure of the hydraulic system being 500 pounds per square inch.

The equipment is so arranged that no mechanism can function until the preceding step has been completed. The transfer mechanism cannot operate until the slides are back, the dowels and drill bushings withdrawn, and the clamps raised. On the other hand, the slides cannot advance until the transfer has been completed, the dowels and drill bush-

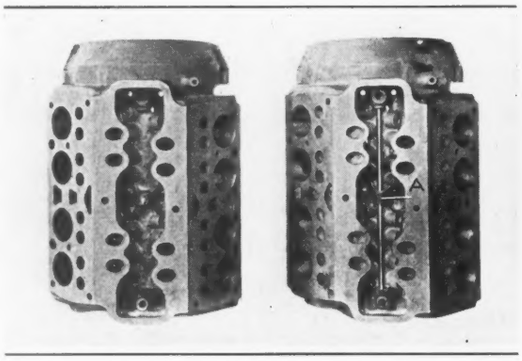
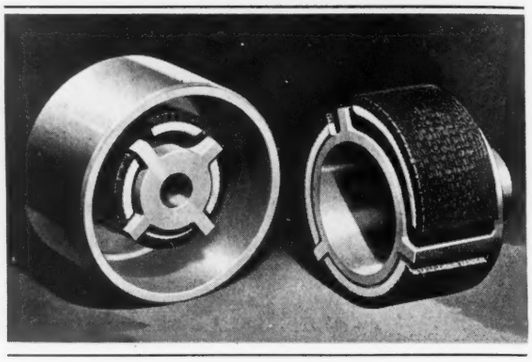


Fig. 1. Cylinder Blocks before and after the Oil-tube Assembling Operation



Coupling which Starts, Couples, Cushions, and Limits the Load

ings inserted, and the clamps lowered. An overload on any one motor will stop the entire machine. The dowels are released if, for any reason, they cannot enter the holes.

The machine operates on five cylinder blocks at one time, delivering a complete block every twenty-eight seconds. The machine weighs approximately 24,000 pounds, and is about 12 feet 6 inches long, 8 feet 6 inches wide, and 6 feet 3 inches high.

U. S. Variable-Speed Buffer and Grinder

A variable-speed buffer, polisher, and grinder similar in appearance to the variable-speed grinder described in December, 1931, MACHINERY, page 311, has been added to the line of electrically driven equipment made by the U. S. Electrical Tool Co., Cincinnati, Ohio. With this machine, an efficient peripheral speed can be obtained for any diameter of wheel. Four wheel speeds are available through gearing. The speeds are changed by means of a lever at the front of the machine.

When the equipment is supplied as a grinder, the selective speed gears are interlocked with the lever in such a manner as to make it impossible to run the grinding wheels at a dangerous rate. The grinding machine is equipped with guards that are adjustable to suit various wheel diameters and wheel wear.

Falk-Rawson "4-Duty" Coupling

A coupling that has been given the trade name of "4-Duty" because it is said to perform four important duties in that it starts, couples, cushions, and limits the load has been added to the general transmission equipment manufactured by the Falk Corporation, Milwaukee, Wis. Primarily, this coupling functions as a centrifugally operated automatic starter which has two drum-shaped members, one attached to the driving shaft and the other to the driven shaft.

Between the driving and driven members are two sets of floating segments which are usually made of brake lining reinforced with lead. The amount of lead provided is calculated to give adequate centrifugal pressure to carry the load. The outer segments are actuated by the driving member and the inner by the driven member. They are said to give just the right combination of smooth starting and overload protection.

The advantages claimed for this coupling are that it makes possible important savings in electrical equipment and that it protects the machine and the product being made. The coupling is made in many sizes ranging from 3 to 400 horsepower, inclusive.

Heald Small-Size Bore-Matic

The automatic provisions incorporated in the Bore-Matic precision hole finishing machines built by the Heald Machine Co., Worcester, Mass. (see May, 1931, MACHINERY, page 705 and November, 1932, page 224) are also features of a smaller size Bore-Matic known as the No. 48, which is now being placed on the market. The latest machine is capable of handling a variety of work either in small shops or in high-production lines. The machine requires no manipulation by the operator except to load, unload, and start.

By merely moving the start and stop lever toward the left, the motor will be started and the table actuated on the "in" stroke at the rapid traverse rate. The table continues at this rate until a cam strikes a boring-feed lever which projects from the top of the control box. It is then slowed down automatically according to the setting of the boring-feed knob, after which it continues moving at the boring feed until another cam strikes the facing-feed lever. At this point, the table feed is reduced still more under the control of the facing-feed knob. A screw in a stop dog finally strikes a lever that cuts off the power to the motor, at the same time braking the motor and the boring heads by means of back pressure against

the pump. The table dwells at the extreme "in" position to give the spindles time to stop before it starts back to the loading position.

The table is hydraulically operated on the boring stroke and returned by a gravity mechanism. A finished pad, 9 inches wide by 22 inches long, is provided on top of the table for attaching fixtures. A hand-crank applied to a screw underneath the table facilitates set-ups.

The machine is driven by a single motor running at 1800 revolutions per minute, which is direct-connected to the hydraulic pump. The boring head is driven from the opposite end of the motor shaft through multiple V-belts. A speed range of from 625 to 3600 revolutions per minute is available with the standard motor, but when lower speeds are required, a motor running at 1200 revolutions per minute and a hydraulic pump of larger capacity can be furnished, so as to obtain speeds of from 425 to 2400 revolutions per minute. Three sizes of boring heads of the Red Head construction can be furnished. With two standard heads, the maximum and minimum center distances are 10 and 5 3/16 inches, respectively.

Newton-New Haven Die-Casting Machines

Die-casting machines that can be changed from job to job in twenty minutes, so that they are adaptable both for short runs on diversified castings and for long runs on one part have been developed by the Newton-New Haven Co., New Haven, Conn. These machines are made in three styles designed for hand, semi-automatic, and full-automatic operation. All three styles employ the positive-plunger injection principle that has been used in die-casting machines for years.

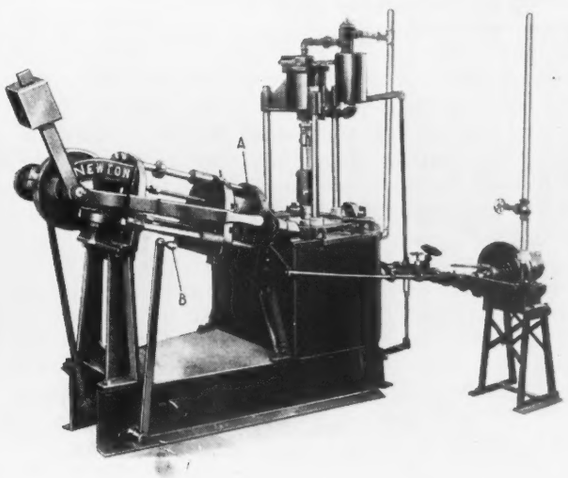
On both the hand and semi-automatic types there are but two levers, while on the full-automatic machine there is only one lever. The semi-automatic machine is shown in the illustration. Lever *A* is raised or lowered to open or shut the die, and lever *B* is moved to the left to make the "shot." Lever *B* is returned by a spring, which at the same time, operates air valves to raise the injector plunger into the self-loading position. The speed of casting is limited only by the speed of the operator. From 400 to 500 "shots" can be made an hour on short runs with the semi-automatic machine, and from 600 to 700 "shots" an hour on continuous runs. With the hand machine, production rates are somewhat lower, and with the full-automatic model, considerably higher. Multiple impression dies can, of course, be used to obtain a larger number of pieces per hour.

All three machines will take dies up to 9 by 12 by 9 1/2 inches, but much smaller dies can be used, with a proportional saving in die cost. In the hand-operated and semi-automatic machines, the dies are quickly closed with a high pressure applied by hand, but without exertion. In the full automatic type, the die closing is accomplished by means of a motor drive.

Carboloy Diamond-Impregnated Truing Tool

The Carboloy Co., Inc., 2481 E. Grand Blvd., Detroit, Mich., has developed a Grade 300 diamond-impregnated truing tool for grinding wheels which supplements the Grades 100 and 200 previously mentioned in MACHINERY. With this addition, the line of truing tools made by

Heald Small Size Bore-Matic Hole Finishing Machine



One of Three Models of Die-casting Machines Built by the Newton-New Haven Co.

the concern covers practically the entire range of finish-dressing. Each of the grades contains a specific type of diamond, Grade 300 being supplied with the best quality diamond particles for the more difficult dressing jobs.

There has also been a further development in the sub-division of each grade of truing tool into three groups based on the mesh size of the diamond particles. This enlarged choice of mesh sizes increases the range of work that can be done by any particular grade, and in many cases enables the user to apply a lower priced grade than would be possible were only one mesh size available. Similarly, the user may select a grade most suitable for his work, and does not need to purchase a more expensive tool when a less costly one will do.

Ex-Cell-O "Junior" Precision Boring Machine

Single- and double-end "Junior" precision boring machines, designed for manufacturers requiring high-precision work on such parts as connecting-rods, pistons, gears, motor end-frames, pump cylinders, and refrigerator compressor bodies, have been added to the line of precision boring machines built by the Ex-Cell-O Aircraft & Tool Corporation, 1200 Oakman Blvd., Detroit, Mich. Among the features of these machines are compact design, low operating cost, full hydraulic control, uniform work, and provision for taking both roughing and finishing cuts on aluminum, bronze, cast-iron, and steel parts.

Ex-Cell-O "Junior" Precision Boring Machine of Single-end Design

One or two boring units can be mounted on the bridge at the left-hand end of the single-end machine illustrated. Two units with in-built motors directly connected to the boring spindle and mounted in the same bracket are shown. However, boring units with the motor above or beside the spindles can be supplied. With the in-built drive, a 3/4-horsepower motor running at 1800 or 3600 revolutions per minute is used, and only one speed is available. When a range of speeds is required, a belt drive is used in conjunction with a one-horsepower motor running at a speed of 1200 revolutions per minute.

The table is provided with T-slots for holding work fixtures. The hydraulic control unit for the table is of Ex-Cell-O design and is mounted at the front of the machine. The rate of table feed in each direction can be adjusted after removing an oval plate. Plungers that extend above the top of the unit are operated by adjustable dogs on the side of the table. The desired operating cycle can be obtained by merely adjusting these dogs. A pressure of 100 pounds per square inch is maintained in the hydraulic system. The main drive motor, together with the hydraulic and coolant pumps, is mounted at the back of the machine.

The double-end machine has a bridge on each end to support the boring units. Each bridge is adjustable longitudinally, the maximum distance between the bridges being 28 inches, and the minimum distance 12 inches. The hydraulic and coolant systems are the same as those of the single-end model.

Murex Electrodes

Two additions have recently been made to the Murex line of heavy mineral-coated arc-welding electrodes produced by the Metal & Thermit Corporation, 120 Broadway, New York City. One of these electrodes is designed for welding Cromansil steel, which has a tensile strength of from 80,000 to 100,000 pounds per square inch, as well as high ductility. This electrode gives a deposit of the same analysis as Cromansil. The weld metal is said to possess physical properties equal to those of the parent metal in every respect.

The second addition to the Murex line is an electrode that deposits a metal containing from 4 to 6 per cent chromium and 0.5 per cent molybdenum. This electrode is especially suited for the welding of petroleum refinery equipment, where metal of this composition is used extensively.

"Pigmy" Precision Ball Bearings

The Norma-Hoffmann Bearings Corporation, Stamford, Conn., has added to its standard line two ball bearings that are of especial interest because of their diminutive size. They are known as the N"463," which has a 1/8-inch bore and a 3/8-inch outside diameter, and the "4666" which has a 3/16-inch bore and a 1/2-inch outside diameter. Despite their small dimensions,

these bearings contain, respectively, twelve and seventeen balls, 1/16 inch in diameter.

These tiny bearings can be used both for rotating and oscillating loads in precision instruments, scales, relays, and similar light-load applications where high accuracy and sensitiveness are essential.

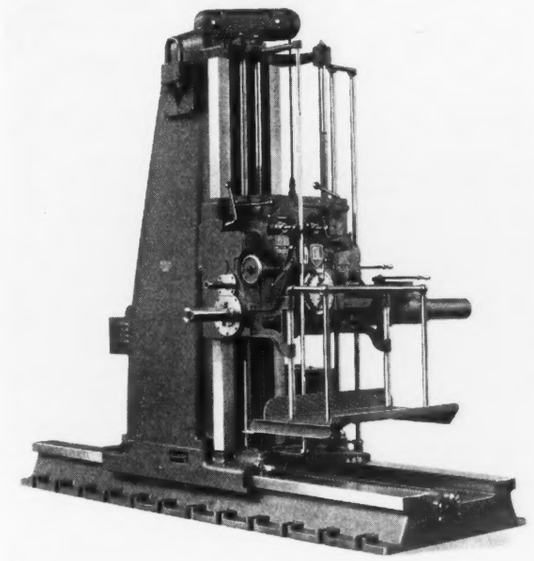
Giddings & Lewis Two-Spindle Boring, Drilling and Milling Machine

A No. 35-F machine provided with a main spindle that runs at a speed of 500 revolutions per minute and an auxiliary spindle having a speed of 1500 revolutions per minute has been added to the line of high-power precision horizontal boring, drilling, and milling machines built by the Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. The high-speed auxiliary spindle permits efficient drilling or boring of even the smallest holes and the use of small end-mills. The lower speed main spindle, intended for larger boring, milling, and drilling operations, is carried by independent bearings, so that the original accurate alignment is always maintained.

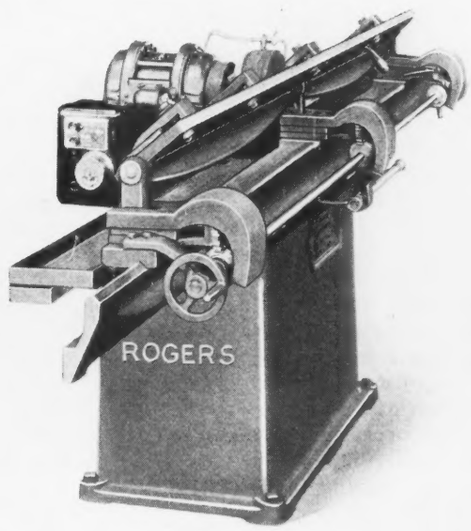
Thirty-six speeds and eighteen feeds are provided for each spindle. All speed changes are obtained through three levers at the front of the head. One lever engages either spindle and also controls the application of the feed to each spindle. The feeds are selected through two levers, and their direction is controlled by means of a third lever. A slow hand-feed for either spindle is also available. The feed can be disengaged at any predetermined depth within 6 inches of spindle travel by means of an automatic trip.

A separate milling-feed unit with eighteen feeds is built into the spindle head to feed the head up or down on the column or the column back and forth on the runway. There is also a hand-feed adjustment.

The operation of the entire machine, including clamping of the spindle head to the column and of the column to the runway, is controlled from a telescoping platform on which the operator stands. Anti-friction bearings are provided throughout the machine, and all parts are automatically lubricated. The machine can be furnished with a maximum travel of the spindle head on the column, of 96 inches.



Boring, Drilling, and Milling Machine with High-speed Auxiliary Spindle

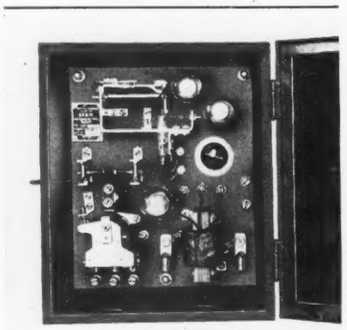


Rogers Automatic Knife Grinder Equipped with Electric Time Control

Rogers Knife Grinder with Electric Time Control

An electric timing device or clock is provided on a Type M automatic grinder recently developed by Samuel C. Rogers & Co., 191-205 Dutton Ave., Buffalo, N. Y., for sharpening light shear blades and woodworking, paper, veneer, and similar knives. This electrical device automatically controls the grinding operation, including both cross feeding and table traversing. It can be set to cut off the power and stop grinding automatically at the end of any period from one to forty-five minutes. Average

knives can be sharpened in from fifteen to twenty minutes. They can be ground away from or toward the cutting edge, and with a flat face or a concave bevel. The rotation of the grinding wheel is instantly reversed at the end of each table traverse, producing smooth sharp knives without wire edges. This machine can be made in lengths of 38, 55, 76, and 90 inches or longer.



Timing Device for Controlling Welding Machines

Timing Device for Resistance Welding Machines

The Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio, has brought out a device known as the "Weld Timer," which is designed to automatically insure the proper welding of parts by accurate control of the number of heat units delivered to the weld. The manufacturer points out that, with manually operated welding machines run at the rate of from 60 to 90 welds a minute, it is practically impossible to control the welding time accurately, since it is only a fraction of a second.

In the operation of an automatic welder, there are many variables entering into the welding circuit which have a direct bearing on the number of heat units put into the weld. A drop in line voltage, for instance, will require an increase in the welding time if uniform results are to be obtained. In plants where a number of welders are connected to the same circuit, the line voltage is likely to vary considerably. There may also be variations in the resistance of the circuit that will affect the current flow. This may be caused by variations in the thickness of the metal being welded, increase in the number of metal pieces, the condition of the electrodes, or the surface condition of the pieces being joined.

The "Weld Timer," which is shown in the illustration, contains a rectifier tube that charges a fixed condenser in proportion to the rate of current flow in the welding circuit. When the charge reaches an amount sufficient to pass current through two neon gas filled tubes, a small relay is operated which, in turn, opens the relay that controls the main line contactor. The tubes are in the circuit only when the welding current is on, so that as soon as the main welding circuit is opened, the "Weld Timer" is ready for the next operation.

The device is readily applicable to commercial types of spot, butt, and projection welders now in service.

B & S Centrifugal and Geared "Motorpumps"

Combination pumps and motors in several styles and sizes are being placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. The unit illustrated at the left has a centrifugal pump intended for use when a large volume of liquid is required under a relatively low head. It is especially adapted for supplying coolant to machine tools, for circulating purposes, for sump drainage, etc., and it is particularly suited for pumping liquids containing dirt, chips, or abrasive particles.

This "Motorpump" is arranged to be mounted either outside the tank of a machine or with the pump set directly in the tank. The discharge pipe can be carried vertically, clear of the motor, thus eliminating the necessity for elbows in the discharge line. The motor is of the drip-proof type, completely enclosed. A sealed bearing is provided below the motor. With a total head of 8 feet, the unit has a capacity for pumping 30 gallons of lard oil or 45 gallons of soda water per minute.

"Motorpumps" of Centrifugal (Left) and Geared (Right) Types

"Motorpumps" of geared type are made by the concern for applications where a power take-off is inconvenient or impossible. Geared "Motorpumps" are made in both horizontal and vertical styles, a vertical unit being shown at the right in the illustration. The individual motor drive permits of mounting the pump in the most convenient location.

When the pump is mounted vertically, a canopy can be furnished, as shown, to prevent dirt, chips, liquids, etc., from entering the motor through the ventilator openings. Spiral gears in both the pump and the reduction drive from the motor insure quiet operation. Speeds of either 600 or 900 revolutions per minute can be furnished. There are three sizes of these units which deliver from 3 to 18 gallons per minute.

Lufkin "Aristocrat" Tape-Rule

A steel tape-rule has been placed on the market by the Lufkin Rule Co., Saginaw, Mich., under the trade name of "Aristocrat," which implies that beauty has been combined with utility in its design. This tape-rule is similar to others previously described in MACHINERY, with the exception of the case, which is made of stainless steel and has an embossed design on both sides with a background in black enamel that gives a black and silver effect.

The steel rule is stiffened by special forming, so that it can be projected unsupported along walls or into openings. However, it may also be flexed around circular parts to take accurate measurements. The case is 1 5/8 inches in diameter.

Controller for Reversing Small Motors

A small drum switch that is designed specifically for use with bench lathes, but may be applied practically anywhere to reverse small motors, has been placed on the market by the Furnas Electric Co., 1525 S. 77th St., West Allis, Wis. The switch may also be used for plain starting and stopping when accurate control is important. The switch is made in a 1/2-horsepower rating for 110- and 220-volt alternating current, and in a 1/4-horsepower rating for direct current.

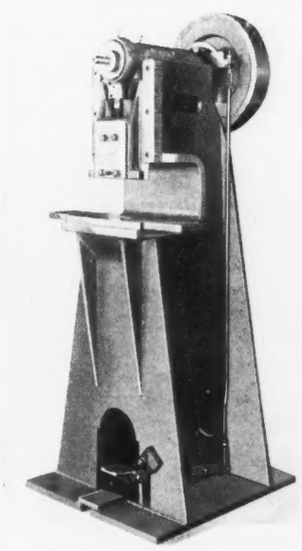
The frame is formed from one piece of heavy-gage steel. The

Drum Switch Designed Especially for Bench Lathes

top is of drawn steel and has a flange that makes the case practically drip-proof. Interior metal parts and the frame are cadmium-plated to make them corrosion-proof. The top, cover, handle stem, and cap have a nickel finish, while the handle knob is red Bakelite. The weight of this drum switch is 17 ounces, and it measures 2 1/2 inches wide by 4 1/4 inches high.

Semco Press with Welded Steel Frame

A 10-ton press with a frame of welded steel has been added to the line of deep-throat punch presses built by the Service Machine Co., 750-760 Broadway, Elizabeth, N. J. The new press is a high-speed machine operating at a maximum rate of 250 revolutions per minute. It is designed particularly for medium punching and stamping operations. The deep-throat housing design permits work of large area to be handled. The standard throat depth for the P-13A press is 8 inches, while the P-13 has a throat depth of 10 1/2 inches. The slide measures 3 1/2 inches from front to back and 7 1/2 inches between the gibs.



Semco 10-ton Press with Welded Frame

The eccentric can be quickly interchanged for various lengths of stroke by removing a nut on the front of the shaft. Any stroke can be obtained up to a maximum of 1 1/2 inches. With the standard stroke of 1 inch, the maximum shut height of the P-13A press is 7 1/2 inches, and of the P-13 press, 12 inches.

The clutch includes a safety non-repeat cam that can be disengaged for nibbling work. The total weight of the machine is about 1600 pounds.

Speedway Automatic Oilers

A line of automatic oilers being introduced on the market by the Speedway Mfg. Co., 1834 S. 52nd Ave., Cicero, Ill., comprises two types known as the Constant Level and the Thermal. The Constant-Level oilers are designed especially for use on electric motor bearings and for other reservoir bearings with an oil-ring, packing, ball bearing or roller bearing, when the oil in the reservoir should be maintained at a predetermined level. The oiler has a tube that permits air to enter and oil to flow when the level of oil in the bearing reservoir drops below the desired amount. The flow of oil is automatically stopped when the proper level is reached.

The Thermal oilers are designed for use on sleeve bearings of the open type. They are operated entirely by changes in

temperature. Heat in the bearing causes expansion of the air in the thermal chamber, forcing small quantities of oil to the bearing. Both types of oilers have a visible oil supply.

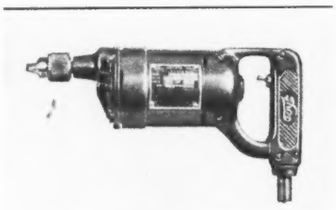
Whitney All-Steel Conveyor Chain

A roller-type conveyor chain of all-steel construction, for which smoothness of operation, strength, and unusual resistance to wear are claimed, has been placed on the market by the Whitney Mfg. Co., Hartford, Conn. This chain can be furnished in various combinations of stainless-steel parts or in an all stainless-steel construction, according to individual needs.

The pitch dimension is double the standard roller-chain pitch. This allows the chain to run on standard cut sprockets, the rolls of the chain engaging every second sprocket tooth. The outside dimensions of the smaller sprockets are changed to compensate for the difference in chordal distance due to the extended pitch.

Thor Quarter-Inch Electric Drill

A light-duty 1/4-inch electric drill equipped with ball bearings at both ends of the armature and with hand-wound and formed coils is the latest addition to the line of portable tools manufactured by the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. Each coil of the motor is insulated three times with silk wrapping. The commutator is a separate unit built up on a brass sleeve that expands and contracts evenly with the copper segments, thus insuring that the segments will not work loose and rise.



Independent Pneumatic Tool Co.'s Light-duty Electric Drill

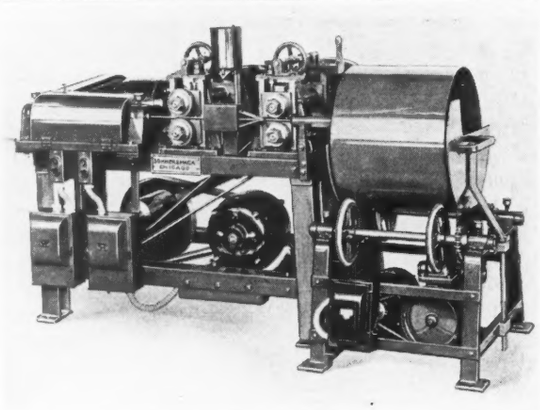
The tool runs at a speed of 2200 revolutions per minute, has an over-all length of 11 1/4 inches, has a spindle offset of 7/8 inch, and weighs only 5 pounds.

Somaca High-Speed Wire-Cutting Machine

Welding wire of various diameters can be cut to standard lengths at the rate of about 300 pieces a minute in a machine built by the Sommer & Maca Glass Machinery Corporation, 3600-3608 S. Oakley Ave., Chicago, Ill. In the same operation, the welding wire can be coated, which is usually done in a separate operation. The machine was developed in collaboration with C. H. Hollup.

Although the machine is intended primarily for the welding wire trade, it can be used to cut wire for other purposes, in lengths from 1 1/2 inches up to several feet. It is claimed that production rates as high as 3600 pieces a minute can be obtained on short lengths of wire. The machine is entirely self-contained, being equipped with three motors. Power is transmitted to the drive shaft through V-belts.

The Sommer & Maca Glass Machinery Corporation has an agreement with the Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J., whereby an arrangement can be made for the user of the machine to process welding wire as mentioned, under a Holslag license.



High-speed Wire Cutting and Coating Machine

Flat Condor Whipcord Transmission Belt

Condor whipcord belting of V-type, which possesses the feature of elastic stretch, has been made for some time by the Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. This concern has now placed on the market a flat endless wound belt with the same trade name, which also has the feature of elastic stretch. It is intended for high-speed, high-tension drives.

This belt is made in widths from 1 to 12 inches and in lengths up to 75 feet. It has a tension section of strong stretchless continuous cord, drum-wound and vulcanized in a matrix of rubber. An elastic wear-resisting envelope of closely woven duck impregnated with high-grade rubber surrounds this cord tension section.

Oliver Double Motor-Arbor Tilting Saw Bench

A tilting saw bench that is especially applicable to pattern shops because it permits quick changing over from a rip saw to a cut-off saw and vice versa has been developed by the Oliver Machinery Co., Grand

Rapids, Mich. This saw bench combines the features of the universal double-arbor saw bench and the tilting arbor miter saw.

There are two shaftless motors, one on each saw arbor. The saw arbors are carried in a revolving yoke that is held in a tilting frame. Any position of the saw between 45 and 90 degrees can be obtained. The table is always horizontal. With the standard 12-inch saws, wood can be cut to a depth of 2 1/4 inches, and with 14-inch saws, to a depth of 3 3/4 inches.

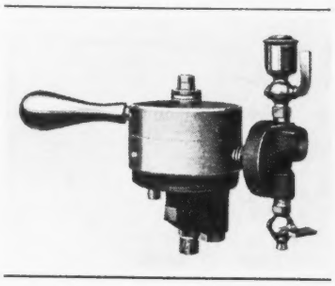
Three-Spindle Adjustable-Angle Spiral Index-Centers

Adjustable-angle index-centers designed for use on universal milling machines in conjunction with the regular dividing head and spiral setting parts have been brought out by John B. Stevens, Inc., 304 Hudson St., New York City. These index-centers are intended for use in the multiple milling of straight or spiral flutes, slots, ratchets, gears, etc. In reality, they comprise a multiple-spindle extension to a regular dividing head.

The index-centers have three spindles, all of which rotate in the same direction. They are connected by gears provided with a take-up for wear and for maintaining the proper mesh. The rated swing of the spindles is 2 inches, and the distance between spindles 2 1/16 inches. Angles up to 17 1/2 degrees, right- and left-hand, are obtainable.

Valve and Oil Filter for Air-Operated Equipment

The Minard leak-proof air-saving type of air valve, formerly made by the National Sales Engineering Corporation, Detroit, Mich., is now being made by the Detroit Tool & Forge Co., 656 Smith Ave., Detroit. This valve can be used in connection with any double-acting air cylinder for operating reciprocating equipment and fixtures. The valve was developed primarily for use in the line that returns the compressed air from the exhaust side to the live side of the cylinder.



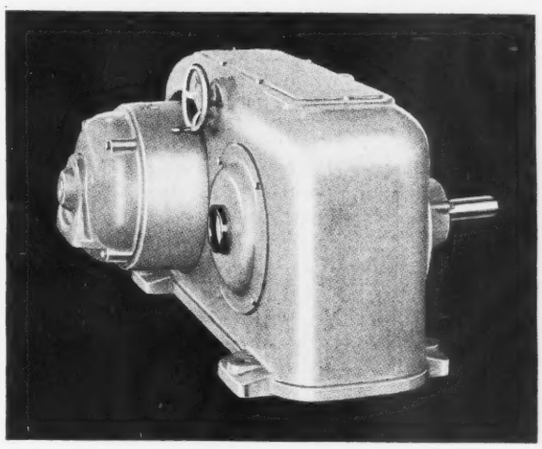
Valve and Filter for Air-operated Equipment

The same company also makes a filter designed to prevent scale, dirt, etc., in the air line from being carried into any make of air valve or cylinder. This filter insures lubrication and prevents rust by mixing oil with the air in the form of a spray.

Sterling Vari-Speed Motors

An infinite speed selection is made available by a line of variable-speed motor units being placed on the market by Sterling Electric Motors, Inc., Telegraph Road at Atlantic Blvd., Los Angeles, Calif. In these units, a heavy, wide, high-speed V-belt runs on two V-pulleys which are mounted on fixed parallel shafts. By turning a small handwheel, the diameter of both pulleys can be changed simultaneously to obtain the desired speed. The proper tension is automatically maintained on the belt. "Slo-Speed" gears can be built integral with the output shaft to provide single or double reductions for slow speeds down to five revolutions per minute. Very high speeds up to 15,000 revolutions per minute can also be arranged for.

These Vari-Speed motors are furnished in both open and closed types and in a variety of ratings, ratios, and combinations. They are ball-bearing equipped throughout. The illustration shows a 15-horsepower unit which operates at a maximum speed of 1200 revolutions per minute and a minimum speed of 300 revolutions per minute. Dust or dirt cannot reach the belt, pulleys, or mechanism.



Sterling Vari-Speed Motor which Provides an Infinite Speed Range

* * *

Motors for Machine Tool Reversals

A field of electric motor drive that has just begun to be touched upon is that of reversing drives. Many machines have cumbersome mechanical arrangements to obtain rapid reversal. Motors are now designed for a large number of reversals per minute. Such motors, however, have to be applied with judgment. It is necessary that the details of the drive and load be carefully considered by the application engineer. In one successful application, mentioned by J. W. Harper of the General Electric Co., a 1 1/2-horsepower motor on a machine tool reverses forty-two times per minute.

NEWS OF THE INDUSTRY

Alabama

McVoy-Hausman Co., Brown-Marx Bldg., Birmingham, Ala., is a new sales agency organized by F. A. Hausman, former head of the Hausman-Harwick Machine Tool Co., of Birmingham, and James L. McVoy, also of Birmingham, who has been conducting a sales agency under his own name. One of the manufacturers that the new company will represent is Bliss & Laughlin, Inc., Harvey, Ill., a manufacturer of cold finished steel bars for over forty years. Another company that will be represented by the McVoy-Hausman Co. is the Poole Foundry & Machine Co., Woodberry, Baltimore, Md., manufacturer of flexible couplings.

New England

Frederick S. Blackall, Jr., was elected president and treasurer of the Taft-Peirce Mfg. Co., Woonsocket, R. I., manufacturer of precision tools and special machinery, at a meeting of the board of directors held July 8. Mr. Blackall, who will continue as general manager of the company, succeeds, in his new office, the late Gordon Gordon of New York, who died June 28. Mr. Blackall has been associated with the Taft-Peirce Mfg. Co. since 1922, and became vice-president and general manager in 1928. He is a graduate of Yale University and of the Massachusetts Institute of Technology. During the World War he served as an officer in the United States Navy. As a member of the American Society of Mechanical Engineers and the American Society for Steel Treating, Mr. Blackall has been especially active in national standardization work. He is a past-president of the Gage Manufacturers' Association. Other newly elected officers of the Taft-Peirce Mfg. Co. are: John W. Wheeler, Jr., of Bridgeport, Conn., vice-president, and William A. Gordon III of Pittsburgh, Pa., secretary.

Frederick S. Blackall, Jr., President and Treasurer, Taft-Peirce Mfg. Co.

Ex-Cell-O Aircraft & Tool Corporation, 1200 Oakman Blvd., Detroit, Mich., has appointed L. W. Sheehy representative of the company in the New England territory, with headquarters at 51 Washington Ave., Cranston, R. I. Mr. Sheehy will handle, in addition to the Ex-Cell-O products, the products of the Continental Tool Works and the Krueger-Wayne Tool Co. divisions of the company.

Colonel Frederick H. Payne, who, in 1929, disposed of his interests in the Greenfield Tap & Die Corporation, Greenfield, Mass., to become Assistant Secretary of War, has rejoined the corporation as chairman of the board of directors. Charles N. Stoddard continues as president and general manager, and, with the board of directors, nine of whom are residents of Greenfield, will direct the affairs of the corporation in the future. Colonel Payne, who will live in Greenfield, will devote his entire time to the affairs of the corporation.

Federated Sales Service has been organized, with headquarters at 537 Commonwealth Ave., Boston, Mass., for the purpose of bringing together carefully investigated manufacturers' agents and manufacturers who seek better distribution of their products. The executives of the concern, Walter A. Allen and John M. Sweeney, have had many years of experience in merchandising work. Mr. Sweeney was formerly vice-president and account executive of Levin & Co., a Boston advertising agency.

H. G. Hoglund has been appointed sales manager of the Machine Tool Division of the Van Norman Machine Tool Co., Springfield, Mass. For the last few years, Mr. Hoglund has represented the General Electric Co. in the New England district.

Wrought Washer Mfg. Co., 2104 S. Bay St., Milwaukee, Wis., has appointed H. M. Swain, 52 Maypole Road, Quincy, Mass., distributor and direct representative in the New England states for its entire line of standard and special washers, corner braces, corner irons and stampings.

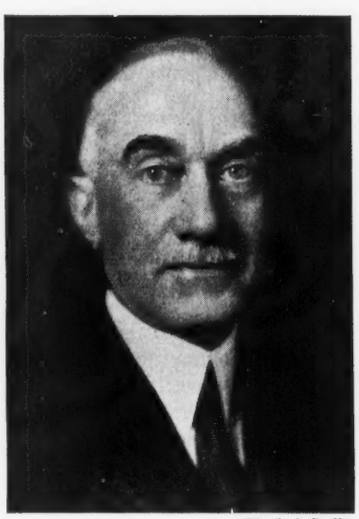
New York and New Jersey

The American Society for Testing Materials at its annual meeting in Chicago elected T. R. Lawson, head of the Department of Civil Engineering of the Rensselaer Polytechnic Institute, Troy, N. Y., president for the coming year. Professor Lawson graduated from Rensselaer in 1898, and has been successively instructor, associate professor, and professor. He has been head of the Civil Engineering Department since 1921. He has conducted important researches on welding and structural materials, and has rendered consulting service on many structural and hydraulic projects.

Crane-Schiefer-Owens, Inc., 501 Morgan Bldg., Buffalo, N. Y., announces that the Buffalo, Rochester, and Syracuse offices of the company are now being operated independently under the following names: R. L. Crane Machinery Co., Buffalo, N. Y.; F. W. Schiefer Machinery Co., Rochester, N. Y.; and J. F. Owens Machinery Co., Syracuse, N. Y. The personnel and organization will continue the same.

B. W. Bullock has been appointed assistant to the manager of the publicity department of the General Electric Co., Schenectady, N. Y., succeeding C W. Stuart, who is taking up special work for the appliance sales group of the company.

Dr. G. H. Clamer, president of the Ajax Electrothermic Corporation, Trenton, N. J., has been awarded the honorary degree of Doctor of Science by Ursinus College, Collegeville, Pa.



Blank & Stoller

G. H. Clamer, Awarded the Degree of Doctor of Science by Ursinus College

Ohio and Indiana

FOSTORIA PRESSED STEEL CORPORATION, Fostoria, Ohio, has recently taken over the production and sale of the Sorwal coolant filter, previously manufactured by the FOSTORIA MACHINE & TOOL CO. of the same city and marketed by the ELECTRIC AUTO-LITE CO., Toledo, Ohio. This filter is especially designed to keep clean the compounds used in grinding, lapping, and honing operations.

TOLEDO SCALE CO., Toledo, Ohio, has established a new service department which is equipped to repair any type of weighing equipment and also to carry on the periodical contact inspection service which has long been maintained by the company. A complete booklet descriptive of the service has been published.

L. A. S. WOOD, manager of the Lighting Products Division of the Westinghouse Electric & Mfg. Co., with headquarters in Cleveland, Ohio, has been elected vice-president of the Illuminating Engineering Society.

INDIANA GEAR WORKS, 1458 E. 19th St., Indianapolis, Ind., has been established, with LOUIS C. BUEHLER as general manager. Mr. Buehler has been connected with the Indianapolis Tool & Mfg. Co. in various capacities for the last thirty-two years. The new company will serve the aircraft engine builder and other users of high-grade gears, cams, and unusually intricate and accurate machine parts.

Pennsylvania

H. C. THOMAS has been appointed sales manager of Micarta products of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Thomas graduated from Purdue University in 1910 and then entered the employ of the Westinghouse company, where, after having passed through a training course in the plant, he became a salesman connected with the St. Louis office. In 1922, he went to New York as assistant to the manager of the Westinghouse merchandising department. Later he was transferred to Mansfield, Ohio, and in 1927 he went to East Pittsburgh in an executive position, later being made assistant to the general works manager.

EARLE GEAR & MACHINE CO., 4709 Stenton Ave., Philadelphia, Pa., announces that the company has obtained the contract for the operating machinery of the Harvey Canal Bridge, Jefferson Parish, La., consisting of complete operating machinery for a double-leaf swing span, the machinery weighing about 34,000 pounds.

FRANK E. CASE, assistant to the engineer of the transportation department of the General Electric Co. at Erie, Pa., has retired, after forty-two years of service. Mr. Case entered the employ of the Thomson-Houston Electric Co. at Lynn, Mass., in 1891, shortly after the formation of the General Electric Co., and in 1894 was transferred to the Schenectady Works.

NORMAN W. STORER, consulting engineer of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been awarded the Lamme Medal by the Ohio State University for his outstanding contribution to the development of electrical street railway apparatus.

Wisconsin, Illinois and Michigan

CHAIN BELT CO., Milwaukee, Wis., has appointed the LEWIS E. TRACY CO., Boston, Mass., distributor for Rex roller, block, and leaf chains and cut-tooth sprockets in the Boston territory. A complete engineering service will be maintained at the Boston office, of which J. K. MERWIN is in charge. The company has also appointed EDGAR STILLEY direct factory representative in the states of Maryland, North Carolina, and Virginia. He will make his headquarters at 210 Snow Bldg., 31 S. Calvert St., Baltimore, Md.

GEORGE C. ISBESTER has become associated with the Philadelphia Division of the Yale & Towne Mfg. Co., and will personally direct the sale of Yale hand and electric trucks and tractors to the railroads in the midwestern territory. Mr. Isbester has been identified for several years with the development of the material-handling methods and equipment for railway terminals, stores, shops, and freight houses. He has been connected with the railway field since 1899. His headquarters will be 713 Railway Exchange Bldg., Chicago, Ill.

George C. Isbester, who will Direct the Sale of Yale Trucks to the Railroads in the Midwestern Territory

ALLSTEEL PRESS CO., 12015 S. Peoria St., Chicago, Ill., manufacturer of the Verson Allsteel line of punch presses and sheet-metal working machinery, has appointed the W. G. NICHOL CO., Mariner Tower, Milwaukee, Wis., exclusive representative of the company in the state of Wisconsin.

T. F. THORNTON has been appointed sales manager of the Detroit district of the Babcock & Wilcox Tube Co., Beaver Falls, Pa., with headquarters in the Ford Bldg., Detroit, Mich. Mr. Thornton has been connected with the automotive and steel industries for many years, and for the last six years has had charge of the sale of tubular products of the Pittsburgh Steel Co. in the Detroit district.

NEW BOOKS

INSTRUCTION BOOKS, DIESEL CORRESPONDENCE COURSE. By Julius Rosbloom. Book No. 1, Fundamentals and Principles. 15 pages, 5 1/2 by 7 1/2 inches. Price, 50 cents. Book No. 2, Treatise on Fuel and Lubricating Oils. 24 pages, 5 1/2 by 7 1/2 inches. Price, 50 cents. Book No. 3, Operation and Maintenance of Engine. 32 pages, 5 1/2 by 7 1/2 inches. Price, 50 cents. Published by the Industrial Institute, Inc., 445 Hoboken Ave., Jersey City, N. J.

NICHROME. 58 pages, 5 by 8 inches. Distributed by the Driver-Harris Co., Harrison, N. J. Price, 25 cents.

This pamphlet has been compiled as an aid to those who are in charge of the selection of alloys used for electrical, mechanical, and chemical purposes. It covers the properties and characteristics of such alloys and describes the applications for which the different types are suitable.

AN INVESTIGATION OF METHODS OF DECARBURIZING IRON-NICKEL-CHROMIUM ALLOYS. By Russell Wendt Dayton. 28 pages, 6 by 9 inches. Published by the Rensselaer Polytechnic Institute, Troy, N. Y., as Bulletin No. 41 of the Engineering and Science Series.

A CHROMIUM-PLATING BATH WITH THE FLUORIDE ION. By Alfred Perlenfein. 36 pages, 5 3/4 by 8 3/4 inches. Published by the Rensselaer Polytechnic Institute, Troy, N. Y., as Bulletin No. 39 of the Engineering and Science Series.

COATED ABRASIVE PRODUCTS. 20 pages, 6 by 9 inches. Published by the United States Department of Com-

merce, Washington, D. C., as Simplified Practice Recommendation No. R89-32 of the Bureau of Standards. Price, 5 cents.

WROUGHT-IRON AND WROUGHT-STEEL PIPE VALVES, AND FITTINGS. 12 pages, 6 by 9 inches. Published by the United States Department of Commerce, Washington, D. C., as Simplified Practice Recommendation R57-32. Price, 5 cents.

INDEX TO A. S. T. M. STANDARDS AND TENTATIVE STANDARDS. 119 pages, 6 by 9 inches. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.

OBITUARY

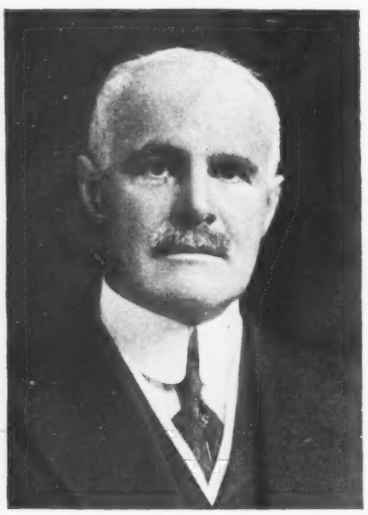
Frank Norman MacLeod

Frank Norman MacLeod, founder and president of the Abrasive Machine Tool Co., Providence, R. I., died June 25 at his summer home at Harwichport, Mass., after a long illness. Born in East Providence in 1866, he was sixty-seven years old at his death.

Mr. MacLeod started his mechanical training as an apprentice with the George H. Corliss Engine Works in 1886. In 1890, he became connected with the Brown & Sharpe Mfg. Co. as inspector, and later served as chief inspector with this company for five years. In 1898 he went to Europe to represent the Brown & Sharpe Mfg. Co., making his headquarters in Glasgow. After his return to America, in 1913, he was put in charge of the grinding machine department of the company. In 1916 he organized the Abrasive Machine Tool Co. and was its president until his death.

Mr. MacLeod took an active part in the work of the National Machine Tool Builders' Association and served as vice-president and director of that organization. He was also a member of the Providence Chamber of Commerce.

Mr. MacLeod is survived by his wife, three sons, and one daughter. The sons, Norman D., Colin G., and Kenneth B., are all active in the business founded by their father.



Frank Norman MacLeod

COMING EVENTS

AUGUST 28-SEPTEMBER 4—INTERNATIONAL AUTOMOTIVE ENGINEERING CONGRESS to be held at the Palmer House, Chicago, Ill., under the auspices of the Society of Automotive Engineers. John A. C. Warner, general manager, 29 W. 39th St., New York City.

SEPTEMBER 15-16—Annual convention of the NATIONAL ASSOCIATION OF FOREMEN at Akron, Ohio. Secretary, E. H. Tingley, Refiners Bldg., Dayton, Ohio.

OCTOBER 2-6—NATIONAL METAL CONGRESS AND EXPOSITION in Detroit, Mich., under the auspices of the American Society for Steel Treating. Secretary, W. H. Eisenman, 7016 Euclid Ave., Cleveland, Ohio.

* * *

Machinery and Allied Products Institute Formed

Headed by John W. O'Leary of Arthur J. O'Leary & Son Co. as president, the Machinery and Allied Products Institute has been formed (with headquarters at 134 S. La Salle St., Chicago, Ill.) by an organization committee including many of the most prominent leaders in the machinery industry. Membership in the Institute will be limited to organizations of firms or individuals in the machinery industry. The new organization will take up the task of coordinating the activities of the various groups in the industry, and is not intended to replace any of the existing trade associations; it will be a coordinating agency to which the specialized associations may look for guidance in policies affecting the machinery industry as a whole.

"Under the new laws so directly affecting industry," says Mr. O'Leary, "business must organize on a larger scale than ever before. It rests with the industry as a whole to make the most of the possibilities that the Industrial Recovery Act affords."

The Cheerful Side

The National Automobile Chamber of Commerce reports that the total production of the members of the Chamber for June amounted to 195,178 cars and trucks. This is more than double the output of the same group for the corresponding month in 1932, and represents a gain of 13.2 per cent over the production for May this year.

The production during the first six months of 1933 was 800,000 cars and trucks, as compared with 680,000 for the corresponding months in 1932. The figures given do not include the Ford production, which is now running fairly high.

Steel production has risen to around 60 per cent of capacity. On July 1, ninety furnaces were in blast, as compared with sixty-three a month ago. The steel output in June was the largest since April, 1931. Many machinery builders also found June the best month since the end of 1931. Railway car loadings are increasing, and the net operating revenues of the railroads are substantially larger than a year ago. The Baldwin Locomotive Works booked more orders in June than in any month since November, 1931, and about three times as many as in June last year. The American Airways, Inc., report that air travel in June broke all previous records.

The Westinghouse Electric & Mfg. Co. has notified its employes that there will be an immediate increase in salaries and wages of 5 per cent in all the offices, works, and subsidiary companies. This increase became effective July 1. In this manner, the company is taking an important step in the effort to further the nation-wide industrial recovery program inaugurated by President Roosevelt.

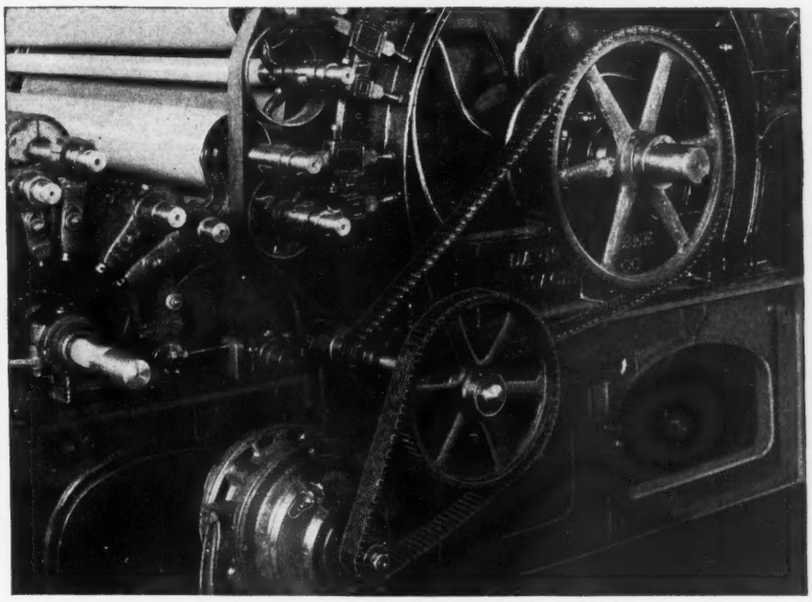
Farrel-Birmingham Co., Inc., Ansonia, Conn., announces that all hourly rates in the Ansonia, Derby, and Buffalo plants of the company were increased 10 per cent, beginning Monday, July 10. The normal working hours consist of five days of eight hours each, or forty hours a week.

The Ohmer Register Co. reports a sharp upturn in the company's business. The volume of cash register sales for June, 1933, exceeded that for June, 1932, by 73 per cent. Sales in July, up to the middle of the month, indicate a substantial increase over June.

The General Electric Co. announces that orders received during the second quarter of 1933 amounted to $35,539,858. This is a slight increase over the value of orders received during the corresponding quarter last year.

The June orders for machine tools mark the highest point in fourteen months, exceeding every month since April, 1932. It is of interest to note that this is true not only of the industry as a whole, but of each of seventy-one companies reporting on orders and shipments. In the general machinery field also, several big orders are recorded.

PERFORMANCE . . . that gives a PROFIT



MANUFACTURERS in every line of industry rely on Whitney Silent Chain Drives to uphold the performance of their equipment and to keep down operating cost. Their long life and efficient service with a minimum of maintenance expense makes profitable operation possible even under fluctuating production schedules.

Whitney Silent Chain Drives can be depended upon to bring out the best performance in any piece of equipment. They give all the power that is needed without excessive losses in transmission, and maintain constant machine speeds.

Whitney engineers will gladly work with you on your power drive problems. Write or phone the nearest Whitney office.

WHITNEY

SILENT AND ROLLER CHAIN DRIVES

THE WHITNEY MFG. CO., HARTFORD, CONN.

BOSTON	CHICAGO	CLEVELAND	DETROIT
NEW YORK	PHILADELPHIA	SAN FRANCISCO	SYRACUSE

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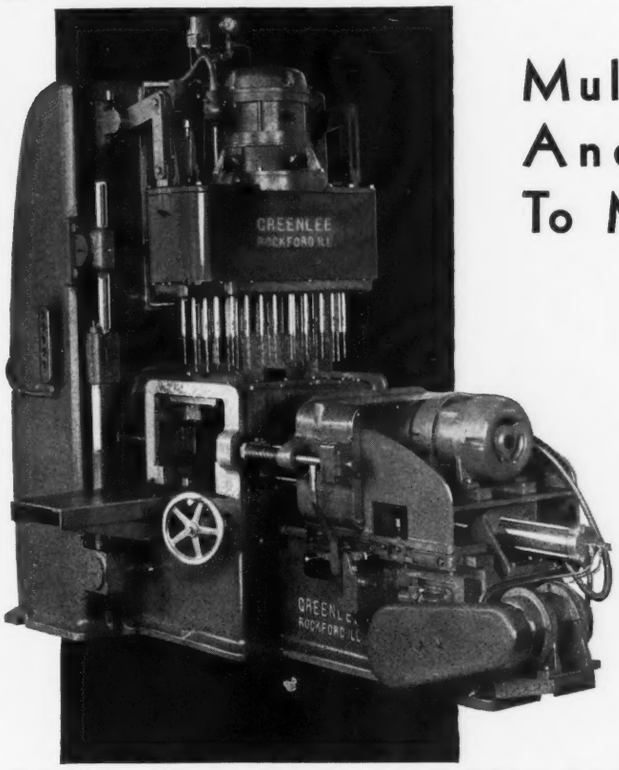
Your Progress Depends Upon Your Knowledge of Your Industry

MULTIPLE-SPINDLE DRILLING AND TAPPING MACHINES

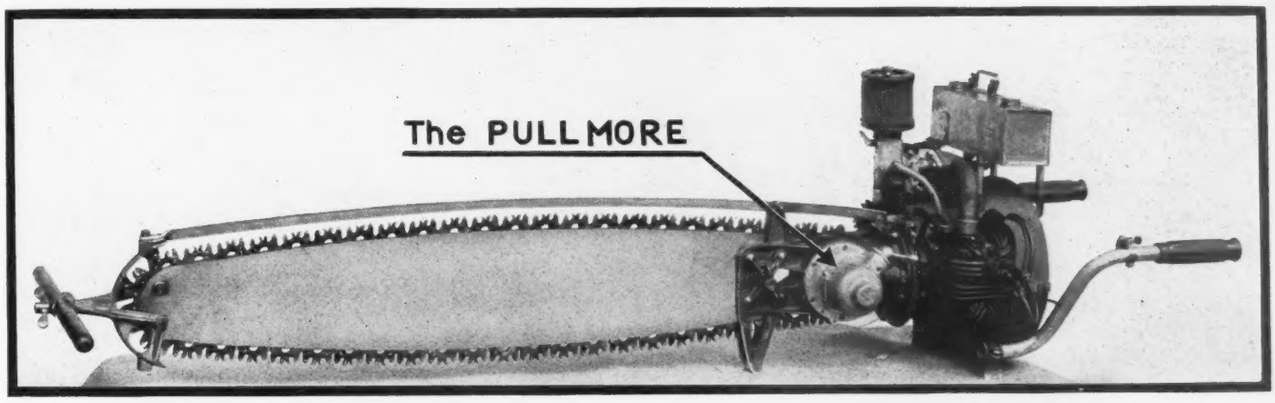


Multiple-Spindle Drilling And Tapping Machines To Meet Your Every Need

REGARDLESS of what your product is or what type of drilling or tapping machine is required—whether it be horizontal, vertical, or a combination of both—you may be sure that the experience, personnel and equipment of the Greenlee organization is such that the machine built by it will measure up to your expectations. It will be fast, strong, convenient to operate, and the price will be right. And that is about everything that can be expected of any drilling or tapping machine.

Greenlee BROS. & CO.
ROCKFORD, ILLINOIS, U.S.A.

FOUR-SPINDLE AUTOMATICS — SPECIAL MACHINERY



Pullmore Clutches Used

This gasoline motor-driven portable saw; manufactured by the Reed-Prentice Corporation, of Worcester, Mass.; is a self-contained unit. The sawing action is controlled independently of the motor through a PULLMORE Industrial Clutch. The saw is used for cutting timbers in the railroad, mining, marine and general construction fields; on the waterfront for cutting piles and large diameter poles; also in the woods for felling and bucking timber. Cutting time for an 8″ diameter Balsam is reported at 3.4 seconds, 20 seconds for a 15″ diameter Rock Maple, and 55 seconds for a 20″ diameter Elm.

ROCKFORD DRILLING MACHINE CO.
310 CATHERINE ST. ROCKFORD, ILLINOIS
Sold by MORSE CHAIN CO., Ithaca, N. Y.
With offices in principal cities

What *They* Say

[UNSOLICITED]

"We recently purchased on our order No. 8246 a No. 1 Single dry type PULLMORE Clutch. This clutch was used for experimental purposes in connection with our Portable Saw and has proved very satisfactory. As it is our intention to use this clutch extensively in connection with the gasoline motor driven type of saw, we should be glad to have you favor us with your best price and delivery on lots of . . . "

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Published by SUNDSTRAND *Machine Tool Co. Rockford, Ill.*

ENGINEERED PRODUCTION

EXAMPLES FROM THE SUNDSTRAND FILES

Lathes Milling Machines Centering Machines Balancing Tools

Vol. IV, No. 5

Aug., 1933

Do You Have Work Like This?

Illustrated in Fig. 1 is the fixture and tooling for chamfering and facing both ends of a work-piece at the same time. Material is steel tube, part of rear axle assembly of a light truck. Fixture has guide bushings for supporting the large cutters, is self-centering, and compensates for variations in diameter of work. Operator on this job easily handles 85 to 100 pieces per hour.

A Sundstrand No. 56 Drilling and Centering Machine, on which this work is done, is shown with standard vises in Fig. 2. This heavy, powerful, accurate machine-tool will handle a wide variety of work profitably and often save subsequent machining operations. Features of the machine, and eight different applications, are shown in latest circular —write for it *today*. If you have work, either single-end or double-end, similar to that shown it will pay you to investigate our No. 56 Drilling and Centering Machine.

Sundstrand Machine Tool Co.

Lathes - Milling Machines - Centering Machines - Balancing Tools

ROCKFORD ILLINOIS, U.S.A.

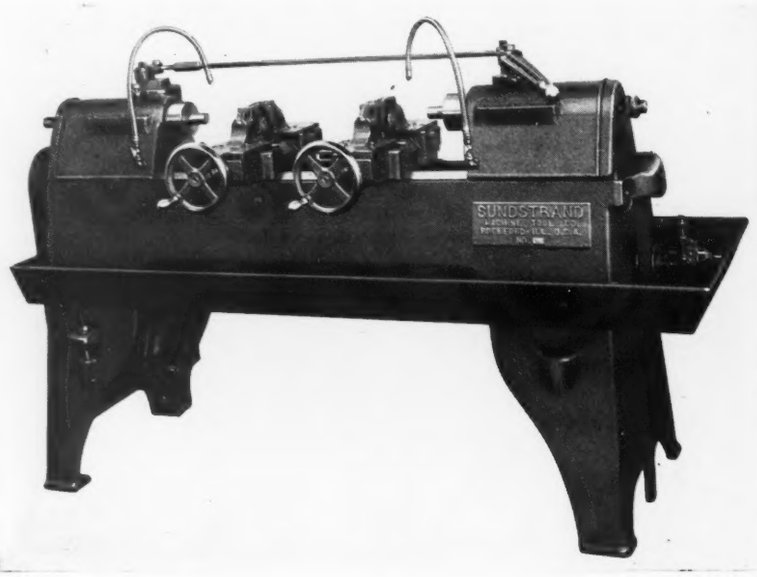


Fig. 2. Above. Sundstrand No. 56 Drilling and Centering Machine.

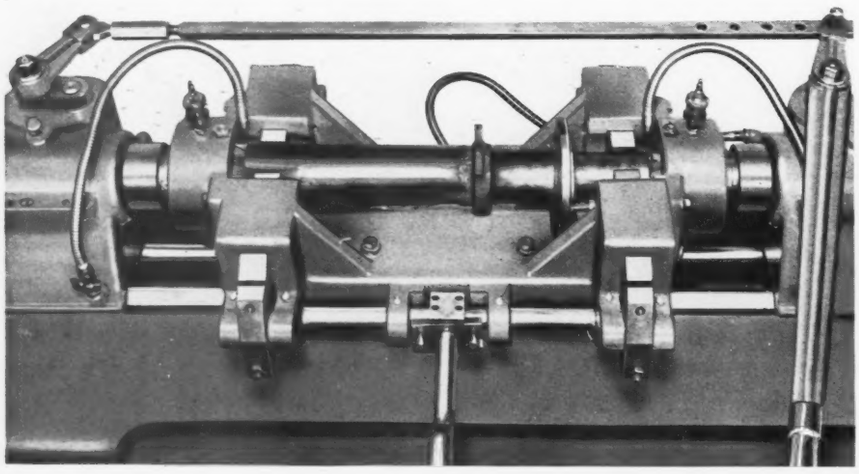
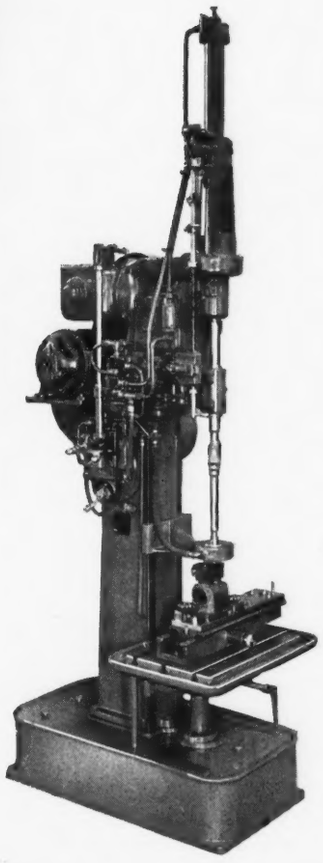


Fig. 1. At left. Set-up for chamfering and facing both ends of rear axle housing and flange assembly.

Made in ROCKFORD ILL., U.S.A.

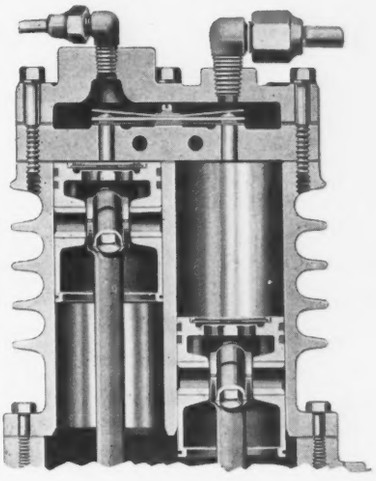


Compressor Cylinders Are Finished By Honing

No. 204 Self-Oiling All-Geared Internal Honers, as illustrated at left, are used for finishing the cylinder bores of Duplex Compressors shown in cross section at right. Why? Because Self-Oiling All-Geared Honing creates bores extremely accurate in size and shape with a superlatively fine, smooth finish thus raising the quality of the product, lengthening its life, *and reducing its production cost.*

A complete line of Self-Oiling All-Geared Honers provides this rare and highly desirable combination of advantages for all bores, from the smallest which can be honed up to the largest and longest. Investigate! Write today for Bulletin No. 121 and Honer Catalog M.

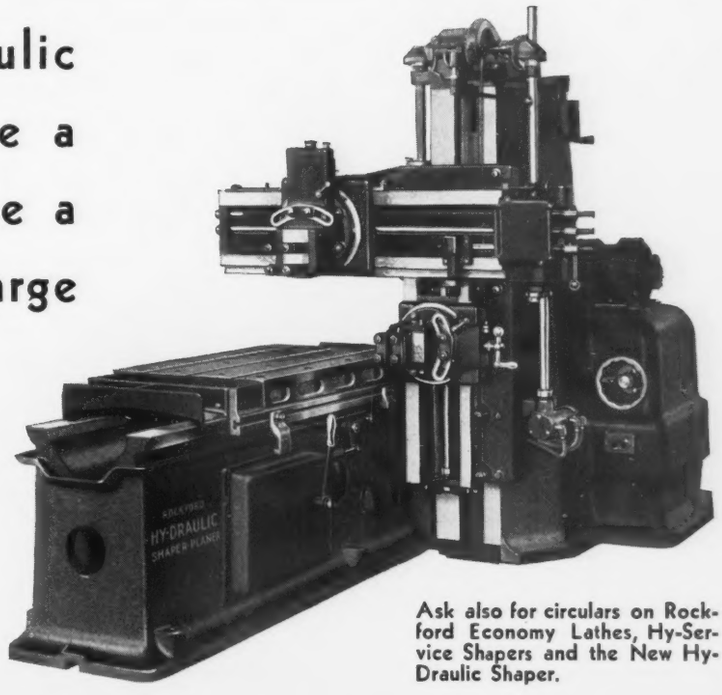
BARNES DRILL CO.
814 CHESTNUT STREET
ROCKFORD - ILLINOIS



Cross Section of Duplex Compressor used in well known refrigerator. The cylinders are honed to a beautiful finish, extremely accurate in size and shape, on No. 204 Self-Oiling All-Geared Honers. This is better, faster, and cheaper than other methods of cylinder finishing.

The Rockford Hy-Draulic Shaper-Planer can save a lot of "grief" and make a substantial profit on large shaper- and small planer-work. Why? Let us tell you in detail. . .

Write today for complete information.



Ask also for circulars on Rockford Economy Lathes, Hy-Service Shapers and the New Hy-Draulic Shaper.

ROCKFORD MACHINE TOOL CO.
. . . . LATHES . . . SHAPERS . . . SHAPER-PLANERS
ROCKFORD, ILLINOIS, U. S. A.

Made in ROCKFORD ILL. U.S.A.

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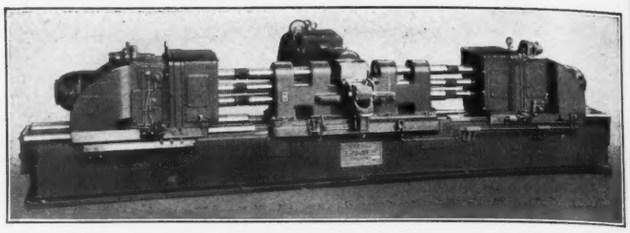
CONVERTIBLE
HYDRAULIC
MACHINE TOOLS

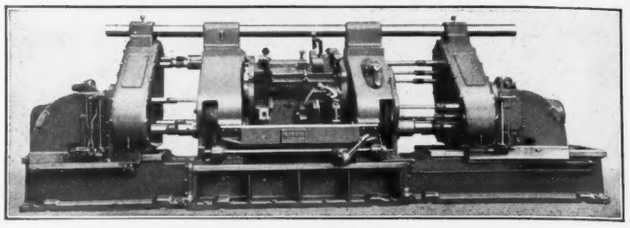
Barnes Boring and Drilling Machines establish and maintain desired accuracy at a high production rate and very low operating cost. They are readily applied to special requirements on a wide range of work, in combinations limited only by the work-piece and the production desired.

The Barnes Self-Contained Hydraulic Heads can be rearranged for machining other work—a convertible feature which substantially increases total profit on original capital investment.



Above—Barnes Machine for boring seven large holes simultaneously in tractor transmission case. Close limits on size and alignment.

Below—Barnes Boring and Drilling Machine for mower frames. It is big, powerful, fast.



Details of machines shown above, and others, on request. Send us drawings and data for reliable production and cost estimates on your own work.

Est. 1872

W. F. & John BARNES Company
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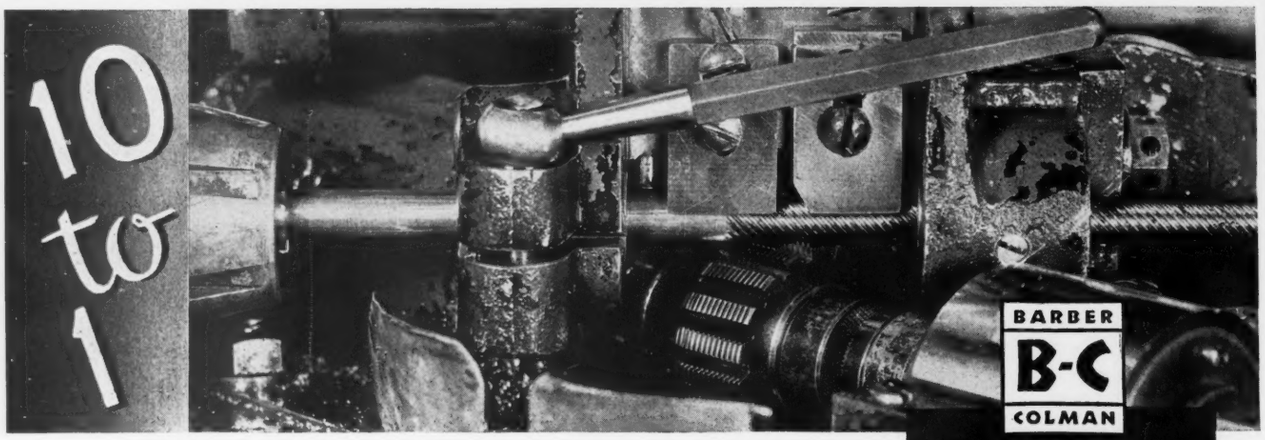
HYDRAULIC
MACHINE TOOLS
ROCKFORD, ILLINOIS, U.S.A.

ACCURATE POWERFUL ECONOMICAL
BORING and DRILLING MACHINES



Above is a "close-up" of a Barber-Colman No. 3 Hobbing Machine cutting 12 teeth, 48° helix, on a steel bar 5/8" diameter. Later, these bars are cut up in an automatic screw machine to make knives for pencil sharpeners. Previous production on cutting the teeth was 25 inches an hour. The set-up shown hobs 22 FEET of rod an hour, an increase of more than 10 to 1.

Barber-Colman Hobs and Hobbing Machines of various sizes and types have made many other interesting records in different industries. Write for details.

BARBER
B-C
COLMAN

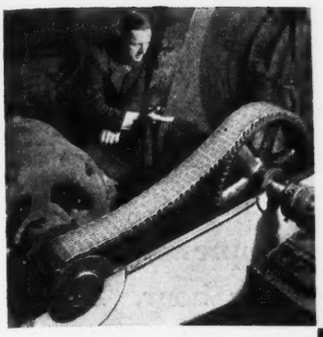
PRODUCTS

MILLING CUTTERS, HOBS, HOBBING MACHINES, HOB SHARPENING MACHINES, REAMERS, REAMER SHARPENING MACHINES, SPECIAL TOOLS

BARBER-COLMAN COMPANY
General Offices and Plant ROCKFORD, ILLINOIS, U. S. A.

Made in ROCKFORD ILL. U.S.A.

Your Money's Worth
in Power Transmission



Silent Chain Drive

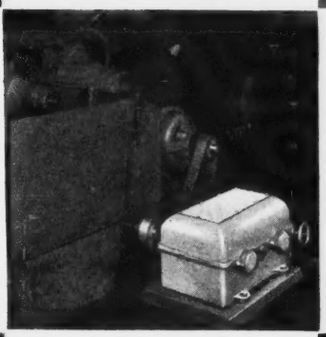
For High Speed Power Transmission Service. 98.2% efficient on actual test. Made in sizes from ¼ to 1000 H.P. and over. Drives ½ to 60 H.P., in speed ratios of 1 to 1 up to 7 to 1, carried in stock by distributors. Send for Data Book No. 125 and Pink Stock List No. 725.

Herringbone Gear Speed Reducer

For Large Reductions, Heavy and Shock Loads. Sykes tooth form gears. Quiet and efficient in operation, withstanding severe shocks. Speed ratios up to 300 to 1. Popular sizes carried in stock. Send for a copy of Book No. 1215.

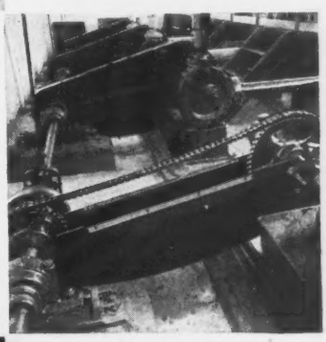
P. I. V. Gear

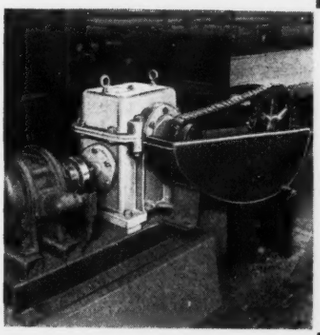
For Positive, Infinitely Variable Speed Control. Power transmitted from input to output shaft through a positive chain drive. Fully enclosed, runs in oil, and is not affected by atmospheric conditions. All sizes in stock. Send for Book No. 1274.



Silverlink Roller Chain Drive

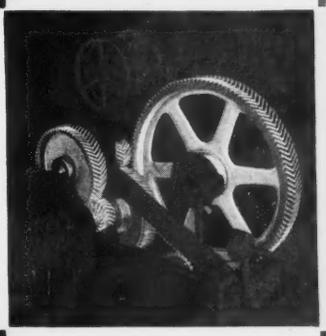
For Moderately High Speed Power Transmission, Heavy or Light Duty. Next in efficiency to Link-Belt Silent Chain. Drives up to 225 H.P. and over, in speed ratios of 1 to 1 up to 8 to 1, carried in stock by distributors. Send for Roller Chain Data Book and Stock List No. 1457.





Worm Gear Speed Reducer

For Positive Driving in Confined Space. A compact, fully enclosed transmission. Anti-friction bearings throughout. Standard motor drives deliver speeds from 46 to 125 R.P.M. Carried in stock. Send for particulars.

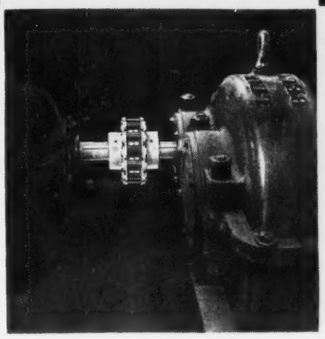


Herringbone Gears

For High-Performance Machinery. A full, continuous tooth, which gives greater strength and bearing surface than teeth of any other form. Prompt shipment. Send for Folder No. 1219.

"RC" Flexible Coupling

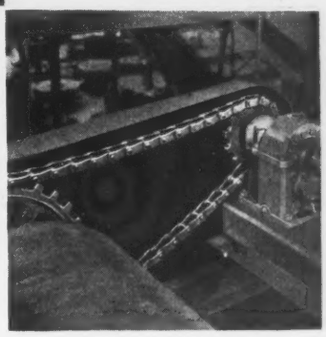
A sturdy, reliable unit, consisting of two, cut-tooth sprockets, and a piece of Silverlink roller chain to connect them. All working surfaces are machined to close tolerances. A pin-and-cotter link makes it easy to couple or remove the chain when desired. Folder No. 1341.



Chain Drives

(Malleable Iron, Steel or Promal)

For Many Average Classes of Service. Light or heavy-duty on cast tooth wheels. Chains and wheels stocked. Complete range of chain drives shown in General Catalog No. 500, Promal Book No. 1050-A, and Steel Chain Book No. 1192.



4758

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Leading Manufacturers of Equipment for Handling Materials Mechanically and Transmitting Power Positively

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LINK-BELT *Positive* DRIVES

(See Our Exhibit at A Century of Progress, Chicago)

320 Compressor Heads—640 Surfaces per Hour

Blanchard Grinder Set-up on Compressor Heads.

THIS No. 16 Blanchard Grinder in the plant of a large mid-west manufacturing company grinds 320 refrigerator compressor heads on two surfaces per hour. The heads are of cast iron, 3 1/8″ dia., and approximately 1/32″ of stock is removed on each grind. In the opinion of the shop foreman the machine is "excellent on this class of work."

Also for grinding the connecting rod and valve plate as pictured at the left, the Versatile Blanchard meets every demand for production and precision.

Grinding these compressor parts, rapidly and accurately, with no expense for fixtures and with no lost time between jobs, is typical of the way a Blanchard delivers on the job. How are you machining your flat surfaces? Let us show you on your own work, what Blanchard Grinding will accomplish. Without obligation send us blueprints or samples today.

THE BLANCHARD MACHINE COMPANY
64 STATE STREET, CAMBRIDGE, MASS.

"Blanchard makes wheels BLANCHARD for Blanchard Grinders"

WORLD SUPREMACY

achieved by

Madison-Kipp

STANDARD

DIE CASTING MACHINES

for almost every die casting requirement . . .

The Growing List Includes the Machines Shown Here and Many Others

Kippcaster No. 15—for all zinc, lead and tin alloys—operated in semi-automatic cycles by hand and foot power—gas or electrically heated metal pot mounted on the side of the machine—accommodates split gate dies.

Kippcaster No. 30—same as Kippcaster No. 15, except gas fired metal pot mounted on end to accommodate center gated dies.

Kippcaster No. 40—for aluminum and magnesium production—operated in semi-automatic cycles—metal is hand ladled—metal plunger equipped with air cylinder for high pressure casting.

Kippcaster No. 55—combination of Kippcaster No. 15 and Kippcaster No. 40 for zinc, lead, tin, aluminum and magnesium casting work.

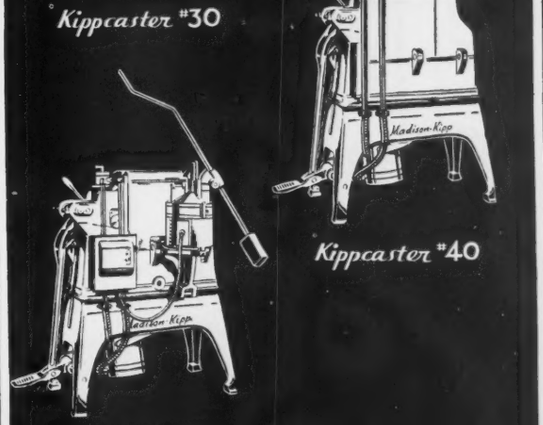
Model No. 2 Madison-Kipp Automatic Die Casting Machine—improved size 10 x 14, weight 7500 lbs.—for casting zinc, lead, and aluminum alloys—one operator—a very popular size. Accommodates fully automatic dies—can be operated at unusually high speeds in zinc alloy production—can be equipped with either air pressure goose neck or plunger goose neck.

Model No. 4 Madison-Kipp Automatic Die Casting Machine—size 12 x 16, weight 14,000 lbs., for zinc and aluminum production—operates with one man—accommodates fully automatic dies—can be equipped with either air pressure goose neck or plunger goose neck.

General—All Madison-Kipp Die Casting Machines and dies are built to established engineering standards. Madison-Kipp offers its customers free consulting service, die designing at a nominal fee and proved die casting dies at definite contract prices. Send samples and blue prints for die prices, production cost estimates or other information.

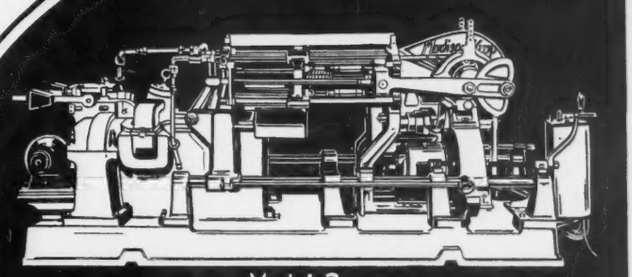
Kippcaster #15

Kippcaster #30

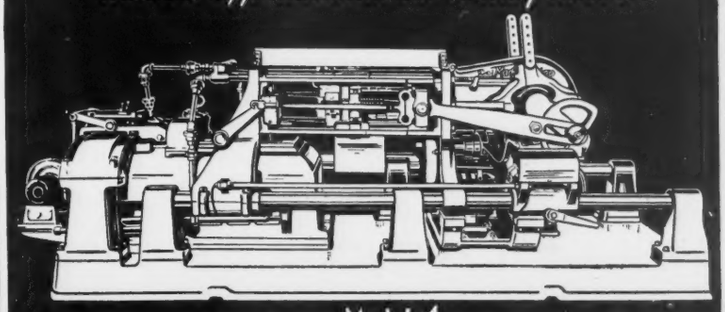


Kippcaster #40

Kippcaster #55



Model 2
Madison Kipp Automatic Die Casting Machine



Model 4
Madison Kipp Automatic Die Casting Machine

PRICED AT $875.00 AND UP f.o.b. MADISON WIS. U.S.A.

Madison-Kipp Corporation

203 Waubesa St., Madison, Wisconsin, U. S. A.

Air Tools Die Casting Equipment Lubricators

Teeth for the Job

UNION

From the tiny needle-like teeth of a kitten to the huge tusks of a hippopotamus, nature provides her children with the correct dental equipment for their needs and environment.

Union follows the lead. Careful study of all phases of metal cutting over a long span of years has evolved a line of tools with the teeth for the job, whatever the assignment. Combined with improved features of equal importance in all details of construction, delivery from stock and longer, finer service, Union Tools are "naturals" to improve cutting results. Ask for catalogs and prices. All kinds of special cutters made promptly.

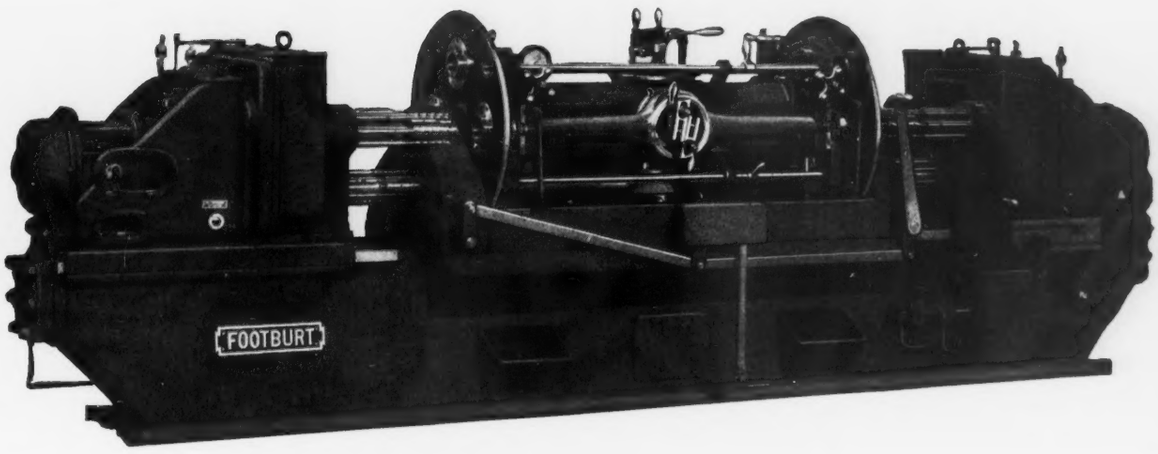
UNION TWIST DRILL COMPANY

ATHOL MASS.

MILLING CUTTERS	TWIST DRILLS	TAPS
GEAR CUTTERS	DIES	HOBS
REAMERS	SCREW PLATES	SAWS

FOOTBURT

WAY DRILLS



ORDINARILY a two machine job, these axle drums have the flange holes drilled and reamed at the same time the ends are being rough, semi-finish and finish bored on one machine.

Flange holes are drilled at rough boring station and reamed at semi-finish boring station, leaving the finish boring station without any additional operation. Detachable heads make it possible to change this machine in case part is changed.

Using a four position drum type indexing fixture, one piece is finished with each cycle of the machine.

Hydraulic feed is used, one lever starting the cycle which continues through fast traverse to the work, slow feed, dwell for counterboring and return.

May we work with you on your drilling problems.

THE FOOTE-BURT COMPANY . CLEVELAND, OHIO

Detroit Office: 4-151 General Motors Building Chicago Office: 565 Washington Boulevard

It's *Easy Threading* with GEOMETRIC

It's easy to cut accurate threads with Geometric Tools.

In the first place, Geometric builds just the Tool you need for the machine on which it is to be used—be it a multiple spindle automatic; a turret lathe; a Brown & Sharpe Automatic; a heavy duty Libby; a Cleveland Single; a drill press or what not.

Secondly, Geometric Chasers are made with exact precision, hardened by experts within close temperature ranges and expertly ground for the work they are to perform.

Lastly, it is easy to put the Chasers into the tool; adjust them for size; take them out for regrinding. You need not be an expert to set up, adjust or operate a Geometric Die Head or Tap.

Catalogs or complete specifications relating to your own work gladly sent on request without obligation.

GEO MET RIC

THE GEOMETRIC TOOL CO.

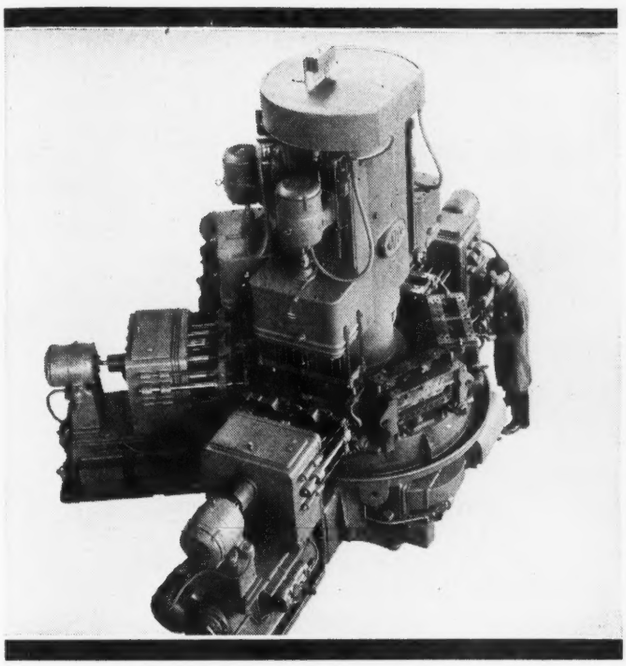
New Haven, Connecticut

Also manufacturers of over 30 years' standing of Collapsing Taps and Threading Machines

THE SKF GALLERY OF DISTINGUISHED PERFORMANCE USERS:

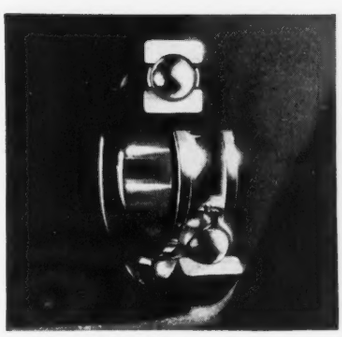
THE NATIONAL AUTOMATIC TOOL CO.

CONTINUOUS QUALITY OUTPUT DEMANDS SKF



PRECISION

ACCURACY...high speed production... are demanded of modern machine tool equipment. SKF Bearings are an important factor in achieving both these objectives with assured continuity of operation and reduced costs. Where machines are expected to stay on the job...SKF Performance Takes Preference Over Price with leading machine tool builders.



On the NATCO Station Type Hydraulic Feed Multiple Spindle Driller SKF is used on the table index worm shaft. This machine performs a total of 132 different drilling and countersinking operations on cast iron cylinder blocks at an approximate rate of 75 per hour. Uniformity of output at this speed is important. SKF precision, long life, freedom from wear and no adjustment insures the utmost reliability continuously.

SKF INDUSTRIES, Inc.
40 East 34th Street, New York, N. Y.

3060

WHERE PERFORMANCE TAKES PREFERENCE OVER PRICE

●*You may buy a bearing as a bargain but try and get a bargain out of using it, for nothing is apt to cost so much as a bearing that cost so little*

SKF
BALL AND ROLLER BEARINGS

YOU PAY FOR
A DIRECT CONNECTION
SEE THAT YOU GET IT

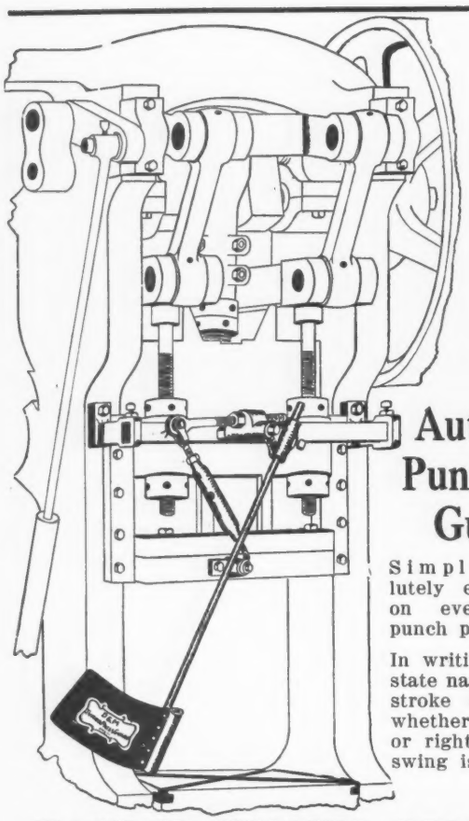
Your long distance, person to person, phone call to a prospective customer gives you a direct connection to the ear of the individual. You are not broadcasting; you are talking to *one* man. You are giving him *your* sales talk.

MACHINERY'S New Deal in Buyer Coverage is definitely comparable. It directs your advertising message straight to the individual you want to reach in the particular plant in which he has the buying influence —the necessary job of modern industrial advertising. MACHINERY'S New Deal is a challenge to indiscriminate *mass* coverage. It proves the inadequacy of the coverage which classifies the executives of large plants and very small plants on exactly the same basis according to titles and which disregards the vital fact that the buying power of the plants behind these individuals may be millions of dollars apart.

Every industrial advertiser is faced with the problem of making each dollar count. To achieve this it is necessary to know *who sees the advertising message; to know the caliber and purchasing power of the plant and the influence on purchasing wielded by the individual reached.* The accomplishment of these all important factors is the purpose of MACHINERY'S New Deal. It is a service that every industrial advertiser has the right to expect for the money he expends for space, and unless he does get it his selling job, from a publicity standpoint, is not up-to-date. Sales Managers, Advertising Managers, Advertising Agencies are united in their enthusiastic support of MACHINERY'S New Deal because it is coverage which gives them a feeling of certainty as to the destination and influence of their advertising. It enables them to plan their advertising with a more direct appeal.

"Who Sees My Advertising?" is the title of a new booklet which every industrial advertiser, sales department and advertising agency should have. Your copy on request.

MACHINERY'S
NEW DEAL IN BUYER COVERAGE



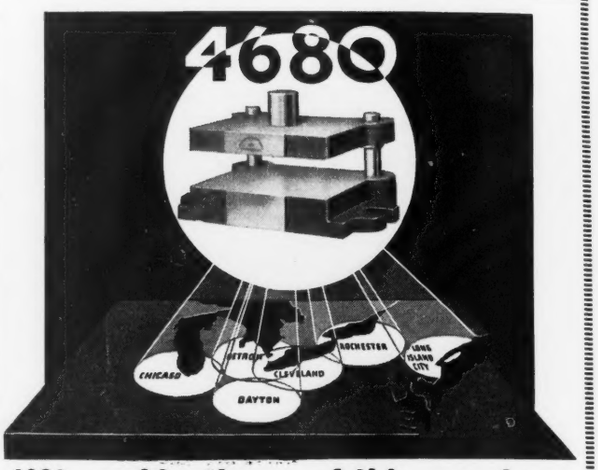
D & M

Automatic Punch Press Guards

Simple—safe—absolutely efficient. Used on every type of punch press.

In writing for details state name, type, size, stroke of press and whether left to right or right to left hand swing is preferred.

TAYLOR-SHANTZ COMPANY
485 St. Paul Street, ROCHESTER, N. Y.



4680 combinations—of this one size—immediately available at these 6 points

4680 combinations of this one size—Danly Regular Standard Die Set—can be shipped from each Danly Branch Office-Plant in 24 hours from each of these 6 points—4680 combinations of size, thickness and material of shoe and punch holder, bushings and length of pin. Thus, any die set requirement can be met under the unique Danly Plan of maintaining stock and assembly plants at six strategic points in industrial U. S. A.

The fact that these six Branch Office-Plants are maintained is the greatest proof that each is able to offer manufacturers in its area better die sets at lower final costs and with faster deliveries. Any of these offices will be glad to place before you complete information on how the Unique Danly Plan makes this possible.

DANLY MACHINE SPECIALTIES, Inc., 2112 S. 52nd Ave., Chicago, Ill.

Branches: Long Island City, N.Y., 36-12 34th St.; Detroit, Mich., 1549 Temple Ave.; Cleveland, O., 1444 E. 49th St.; Dayton, O., 226 N. St. Clair St.; Rochester, N.Y., 16 Commercial St.

DANLY DIE MAKERS SUPPLIES

BETTER-MADE DIE SETS

BAUMBACH

AT LOWER COST

24 DIFFERENT STYLES

OVER 95,000 SIZES

STANDARDIZED DIE SETS

Semi-Steel | Drop Forged Steel

Send for Our New 208-Page Catalog

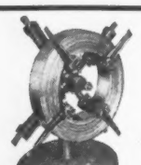
E. A. BAUMBACH MFG. CO.
1810 South Kilbourn Ave. Chicago, Ill.

NIAGARA

PRESSES PUNCHES SQUARING SHEARS

MACHINES AND TOOLS
For Plate and Sheet Metal Working
STEEL DRUM MACHINERY
Stock Deliveries Catalog on Request

Niagara Machine & Tool Works
637-697 Northland Ave., Buffalo, N. Y.
New York City, 50 Church St. Detroit, 2-108 Gen. Motors Bldg.



ANNOUNCING THE NEW LITTELL NO. 3 AUTOMATIC CENTERING
—REEL—
Coils are balanced in a moment. Reel runs easily at all times and is quick to load.

F. J. LITTELL MACHINE CO.
Capac. 300 lb. Coils 4127 Ravenswood Ave. Chicago, Illinois

17 STYLES AND SIZES

MERRELL

PIPE THREADING for BETTER threads MACHINES
TOLEDO, OHIO

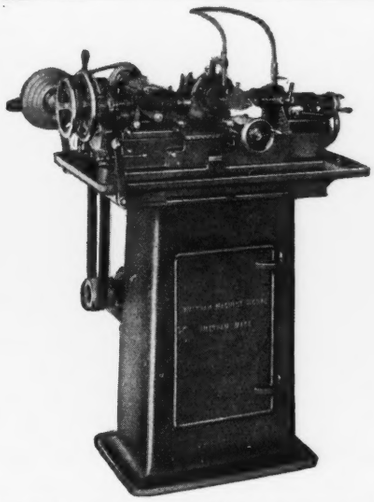
V&O "LONG SLIDE" PRESSES

THE V & O PRESS COMPANY
HUDSON, N. Y.

AUTOMATIC MACHINERY BAIRD BRIDGEPORT CONNECTICUT U.S.A.

WIRE FORMING MACHINES.
FOOT AND POWER PRESSES.
TUMBLING EQUIPMENT.
MULTIPLE SPINDLE LATHES—
For Chucked and Centered Work.

THE BAIRD MACHINE COMPANY
BRIDGEPORT, CONN.



WALTHAM
TRADE MARK
REGISTERED U.S. PAT. OFF.

New Records on Small Part Threading

—with unskilled labor!

The *improved* Waltham is your machine if you thread parts 2″ or less in diameter. We doubt if any other small thread miller is faster or more accurate, and the Waltham offers semi-automatic operation; unskilled operators can run it, at less cost.

It threads internally or externally, and has an 8-¾″ length capacity (10″ with spring chuck). Control is the simplest, and an improved coolant system permits faster and better work.

Full details on request

WALTHAM MACHINE WORKS
NEWTON STREET, WALTHAM, MASS.
Makers of Small Thread Millers, Gear Cutters and other Small Automatic Machines

Swaging—*What* it is and *How* it is done on

DAYTON-TORRINGTON SWAGING MACHINES

All explained in booklet—"The Modern Art of Swaging"—Your copy mailed on request.

Examples of many possible operations by swaging method:—

1 Point rods for drawing
2 Pointed rods and tubing
3 Tapered rods and tubing
4 Acetylene torch tubes
5 Curling iron tubes
6 Nail Sets—Prick Punches
7 Steel furniture legs
8 Tap blanks
9 Ice pick points
10 Meat hooks
11 Refrigerator expansion bulbs
12 Sizing and reducing wire

Present Owners of Torrington Swaging Machines are quoted promptly on request for prices for die renewals, etc.

THE TORRINGTON CO.
55 Field Street Torrington, Conn.

CONE 4-SPINDLE AUTOMATICS

are economical and accurate producers of screw machine parts up to 6″ diameter, 7″ milling length. They cut costs, increase production, boost profits. Write for particulars.

CONE AUTOMATIC MACHINE CO., Inc., Windsor, Vermont

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Pennsylvania: Arch Machinery Co., 1005 Park Bldg., Pittsburgh, Pa.
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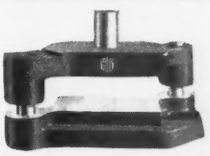
New England: Potter & Johnston Machine Co., Pawtucket, R. I.
California: C. F. Bulotti Machinery Co., 829-31 Folsom St., San Francisco, Calif.



STANDARD DIE SETS

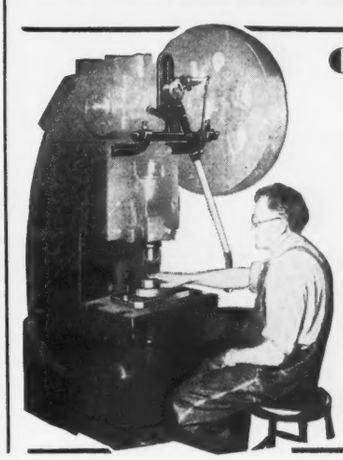
U. S. Tool Die Set sizes indicate ACTUAL WORKING SURFACE. Remember this when you make price comparisons. Ample stocks at conveniently located distributors afford quick deliveries. Die Set Catalog includes Automatic Feeds, Stock Reels, Die Springs, Dowel Pins, Bench and Lapping Plates and other Tool Room accessories.

U. S. TOOL COMPANY, Inc. AMPERE NEW JERSEY

PLANATHREADING PLANAMILLING

Unique production methods make difficult milling and threading pay. Send for illustrated booklet.

THE HALL PLANETARY CO.
Fox St. and Abbotsford Ave., Philadelphia, Pa.



Drilling and Tapping Machines

(Automatic and Semi-Automatic)

LELAND GIFFORD CO.
WORCESTER, MASS.

SPRINGFIELD GEARED HEAD ENGINE LATHES

The Springfield Machine Tool Co., Springfield, Ohio

Operators Like Safety

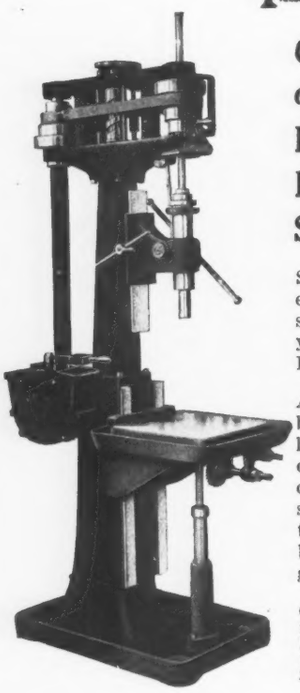
but they hate press guards that slow up the work.

Wiesman Safety Press Guards

permit fast, natural feeding WITHOUT DANGER. Universally applicable, easily attached —right or left-hand swing, they help increase production by insuring safety without impeding the operator. Details?

Wiesman Mfg. Co.
31 to 35 South St. Clair St.
DAYTON, OHIO, U.S.A.

FOSDICK



Check Every Feature of These

BALL BEARING HIGH SPEED SENSITIVE DRILLS

Send for the catalog and check each point in the design and construction of these machines—you'll understand the value of Fosdick "advanced engineering."

All revolving members operate on ball bearings; drive is through hardened nickel steel, spiral gears on ball bearing shafts and running continuously in oil; larger bearing surfaces, greater weight in essential parts—everything, even the base, has been redesigned for greater efficiency.

Complete line—1 to 6 spindles; send for catalogs of these machines, Fosdick Economax Radials 3 to 8 feet, and Fosdick Heavy Duty Uprights 21", 25", 30".

THE FOSDICK MACHINE TOOL CO.
CINCINNATI, OHIO, U. S. A.

THE HIGH SPEED RIVETING HAMMER

(Patented)

Nine sizes for cold riveting, 1/64 to 1 ½ in. in diameter
Send riveting samples for demonstration
Write for Catalog "D"

THE HIGH SPEED HAMMER CO., Inc.
305-321 Norton St., ROCHESTER, N. Y., U. S. A.

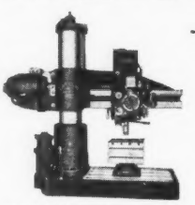
PJ FOR OVER A QUARTER OF A CENTURY PJ

THE PIONEER MANUFACTURER OF AUTOMATIC CHUCKING EQUIPMENT

POTTER & JOHNSTON MACHINE CO.
PAWTUCKET, R.I., U.S.A.

CARLTON RADIALS

—they're faster!



Furnished in a wide range of column diameters and arm lengths, for all requirements. Ask for details.

A low-hung drive to spindle that eliminates chatter; ball bearing equipment throughout; scientific reinforcement at all points of stress that eliminates vibration — these are the three big features that enable Carlton Radials to produce precision work at faster speeds.

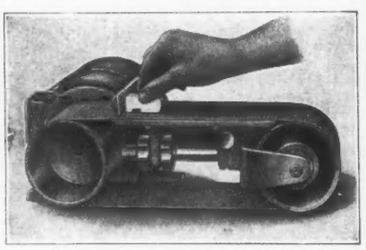
As a result, they're more economical —more versatile. Installed in your shop, an assurance of top efficiency on every drilling job.

THE CARLTON MACHINE TOOL CO.
CINCINNATI, OHIO, U. S. A.

PRODUCTION No. 601
BELT SURFACER and SANDER

A simple, efficient and convenient machine for burring, cleaning, sanding—saves money, does better work at lower cost.

Fool proof construction; operates on regular lighting circuit; furnished complete with motor—ready to plug in. Details?



PRODUCTION MACHINE CO.
GREENFIELD, MASS., U. S. A.

"HOLE HOG"

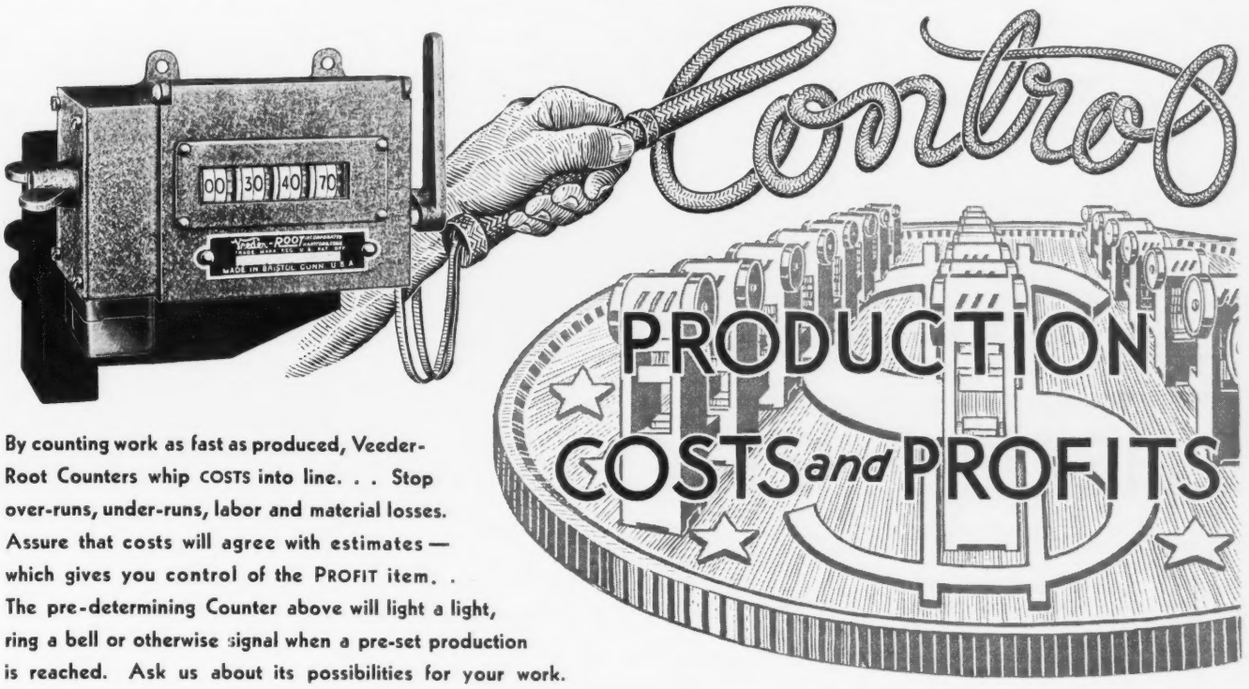
Multiple Spindle Drillers, Borers, Counterborers, Reamers, Lappers, Tappers, and Universal Joint Machines
Particularly Designed for High Production Work
MOLINE TOOL CO., Moline, Ill.

ABRASIVE SURFACE GRINDER

HORIZONTAL and VERTICAL for TOOLROOM and PRODUCTION

Write for Particulars
ABRASIVE MACHINE TOOL CO., East Providence, R.I.

Veeder-Root COUNTERS

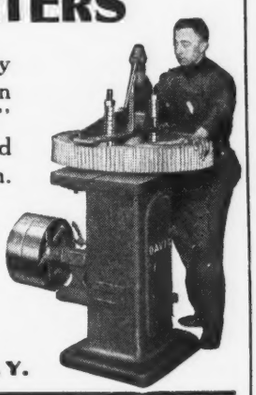


By counting work as fast as produced, Veeder-Root Counters whip COSTS into line. . . Stop over-runs, under-runs, labor and material losses. Assure that costs will agree with estimates — which gives you control of the PROFIT item. . The pre-determining Counter above will light a light, ring a bell or otherwise signal when a pre-set production is reached. Ask us about its possibilities for your work.

BUILDERS OF COUNTERS **Veeder-Root INCORPORATED** HARTFORD, CONN. FOR EVERY PURPOSE

DAVIS KEYSEATERS

Faster, more accurate—takes only 2 minutes to set up the work then the Davis "broaching pull cut" insures better than usual speed and accuracy on the actual operation.



Capacity 1/16" to 1" in hubs to 12"; H.S. and Carbon Steel Cutters in sixteenths and some thirty-seconds. Send for details.

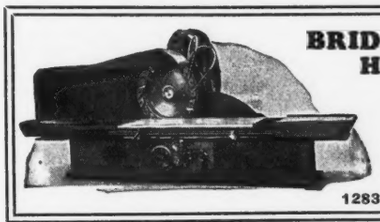
DAVIS KEYSEATER CO.
405 Exchange St., Rochester, N. Y.

Emery Wheel Dressers and Cutters

Two Sizes, Nos. 1 and 2
We make the regular Huntington (Pattern) for all sizes. Roughing for Nos. 1 and 2. Paragon for No. 1 only.
GEORGE H. CALDER CO., Lancaster, Pa., U.S.A.

RING WHEEL **GRINDERS**
for roughing and finishing **FLAT SURFACES**

PULLEY GRINDERS finish Belt Face, Crowned or Straight, from the Rough. Also Truck Treads and shallow circular work.
GRINDER CHUCKS hold Abrasive Rings, 10" to 30" diameter. *Send for Circulars.*
THE GRAHAM MFG. CO. 71 Willard Ave., Providence, R. I.



BRIDGEPORT HYDRAULIC FACE GRINDERS
Rugged, Powerful Machines for Production Work
BRIDGEPORT SAFETY EMERY WHEEL CO., Inc.
1283 W. Broad St., Bridgeport, Ct.

OLIVER
For Better Tool Service

The Oliver No. 2 "Arc" Face Mill Grinder.
The Oliver Tap Grinder.
The Oliver Drill Grinder.
The Oliver Drill Point Thinner.
The New Oliver Tungsten-Carbide Grinder.
The New Oliver Diemaking Machine.
Send for details of Oliver Machines.

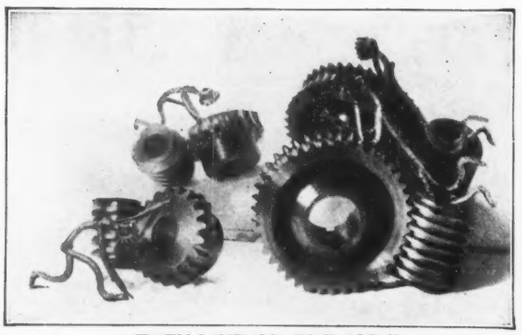
OLIVER INSTRUMENT CO.
1410 E. Maumee Street, Adrian, Michigan
Specialists in Tool and Cutter Grinding Equipment

Thompson Universal Grinders
Thompson Surface Grinders
[Fully Hydraulic]

THE THOMPSON GRINDER COMPANY
1534 West Main Street **Springfield, Ohio**

SEEING DOUBLE—NOT SURPRISING

You may see several times the life in accurate gears.



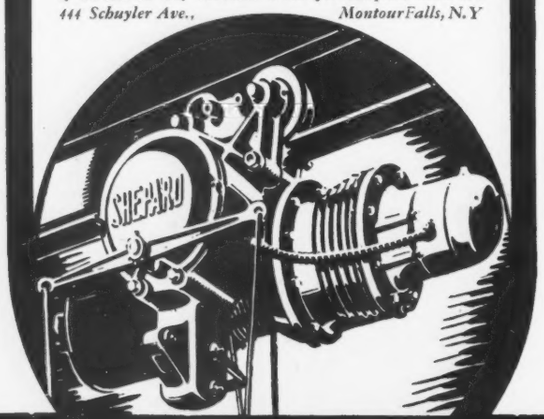
"THEY LIVE ON THE JOB."

Mass. Gears bring into realization this gratifying condition.

Massachusetts Gear & Tool Company
34 Nashua St. Woburn Mass.

SHEPARD
ELECTRIC HOISTS

Exclusive Features: (1) Balanced Drive, at two points diametrically opposite. (2) Perfect alignment, maintained by all parts rotating around a common axis. (3) Automatic Oil Bath Lubrication. (4) Control by rope, push button, outrig or controller for every hoist. (5) Precision variable speed control for both A.C and D.C. (6) Variety of speeds, types, lifts and capacities precisely suited to any service. *Write for complete data to: 444 Schuyler Ave., Montour Falls, N.Y*



SHEPARD NILES
CRANE AND HOIST CORP.

HARTFORD GEARS

SPURS
BEVELS
HELICALS
WORMS
CAMS

Get an estimate on these quality products — specialized equipment, experience enables us to give unusual satisfaction.

The Hartford Special Machinery Co.
293 Homestead Ave., Hartford, Conn.

UNIVERSAL
(HORIZONTAL) BORING MACHINES
UNIVERSAL BORING MACHINE CO.
HUDSON, MASS., U. S. A.
"Where accuracy counts, we win" 4760

Marvel Metal Band Saw Machines

Marvel Ball Bearing High Speed Hack Saws. Plain Shop Saws. High Speed Edge Hack Saw Blades and Hole Saws. Punches, Shears, Rod Cutters, Drill Press Vises. Write Us Today.

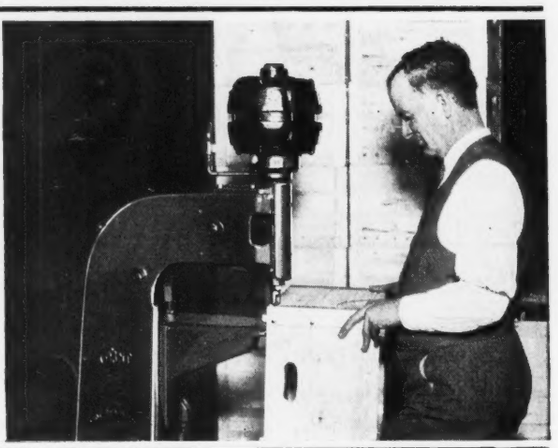
ARMSTRONG-BLUM MFG. CO.
343 N. FRANCISCO AVE. CHICAGO, ILL.

GRANT Riveting
STURDY BOTTLE CARRIERS

Strength to stand up to hard usage, economy that meets price competition—assembling these metal bound wooden bottle carriers on Grant Noiseless Rivet Spinners meets demands on both price and service.

Grant Riveters are made in two models, in many sizes for all classes of work. If you want to set well finished rivets, tight or loose, in any material send for details of Grant Noiseless Rivet Spinners and Grant Rotary Vibratory Riveters.

THE GRANT MFG. & MACHINE COMPANY
N. W. STATION, BRIDGEPORT, CONN.



STANDARDIZATION PAYS

MEMBER OF AGMA

MOTORIZED!

SPEED REDUCTION

The Boston Motorized Worm Gear Speed Reducer is more than just a speed reducer and motor combined, it is an especially designed speed reducer and a standardized motor—"UNITIZED."

This Motorized Speed Reducer is designed to meet the demand for a simple, rugged, and COMPACT power unit that will give long and efficient service at low cost.

The worm and the motor shaft are made integral. This assures quietness and positive alignment.

All models are equipped with General Electric Co. motors. Other makes of motors may also be used economically, but only when the complete assembly is produced in quantities.

Boston Motorized Speed Reducers are available in various sizes, horsepowers, and speeds.

Submit your specifications for recommendations.

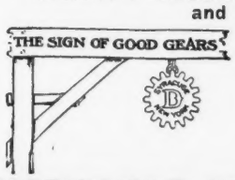
BOSTON GEAR WORKS, Inc., Dept. M, North Quincy, Massachusetts

BOSTON GEARS

DIEFENDORF GEARS

ALL KINDS IN ALL METALS

ALSO SPECIALISTS IN
MICARTA—CELORON—FORMICA—FABROIL
and RAWHIDE



FULLY EQUIPPED FOR

SPIRAL BEVELS

LET US QUOTE

DIEFENDORF GEAR CORPORATION
SYRACUSE, N. Y., U. S. A.

CULLMAN SPROCKETS

OVER 45,000 SPROCKETS
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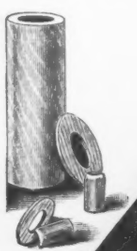

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BUSHING BEARINGS
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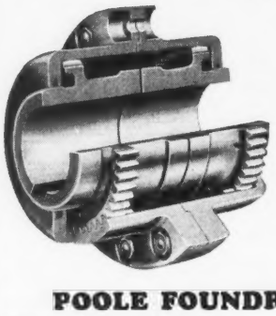

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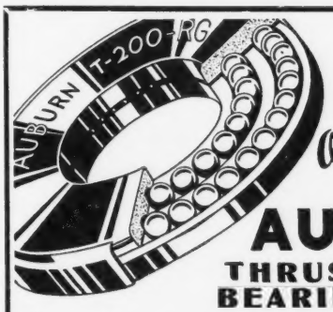

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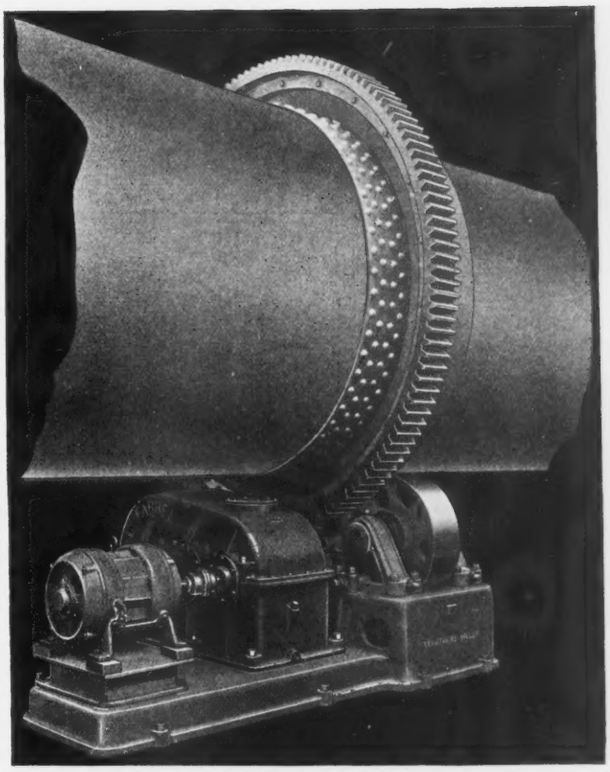

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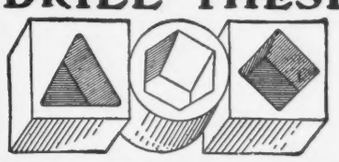

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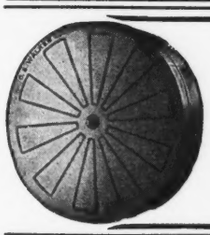

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FOR LOCATION OF ADVERTISEMENTS OF MANUFACTURERS LISTED IN THIS INDEX SEE ALPHABETICAL INDEX, PAGE 62

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Elmes Engineering Wks., Chas. F., 222 N. Morgan St., Chicago
Farrel-Birmingham Co., Inc., 377 Vulcan St., Buffalo, N. Y.
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See Hoists, Air.

AIR TOOLS
See Grinders, Pneumatic; Drills, Portable Pneumatic, etc.

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Ramet Corporation of America, North Chicago, Ill.
Republic Steel Co., Youngstown, O.

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See Presses, Arbor

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Standard Tool Co., Cleveland.
Union Twist Drill Co., Athol, Mass.

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S K F Industries, Inc., 40 E. 34th St., New York.
Waterbury Steel Ball Co., Inc., Poughkeepsie, N. Y.

BARS, BORING
See Boring Bars.

BARS, PHOSPHOR BRONZE
Bunting Brass & Bronze Co., Toledo, O.

BARS, STEEL
Carnegie Steel Co., Pittsburgh, Pa.

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Link-Belt Co., Chicago, Ill.

BEARINGS, BALL
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Boston Gear Works, Inc., North Quincy, Mass.
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New Departure Mfg. Co., Bristol, Conn.
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Schatz Mfg. Co., Poughkeepsie, N. Y.
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See Hoists, etc.

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General Electric Co., Schenectady, N. Y.

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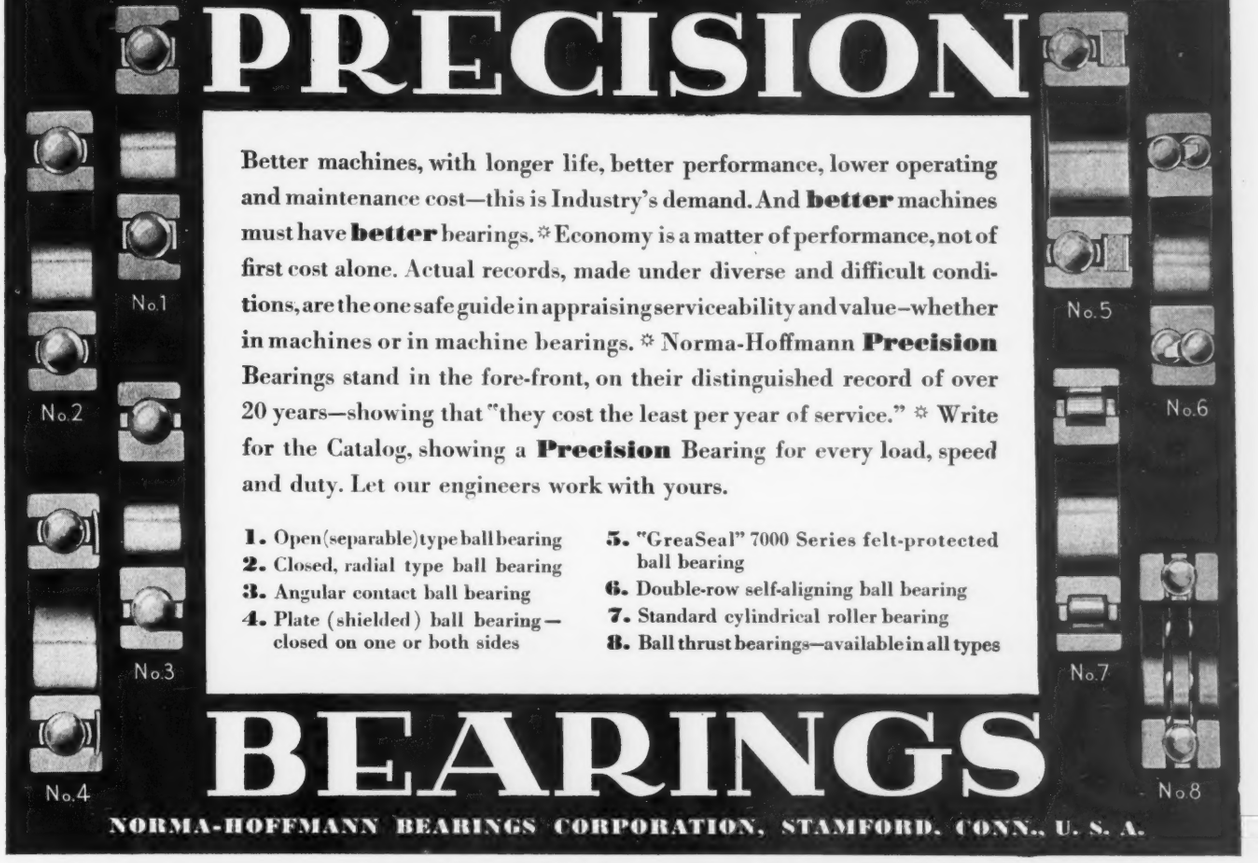

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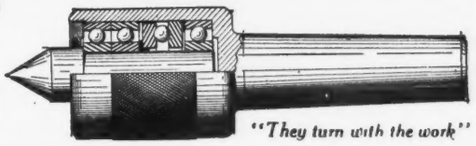

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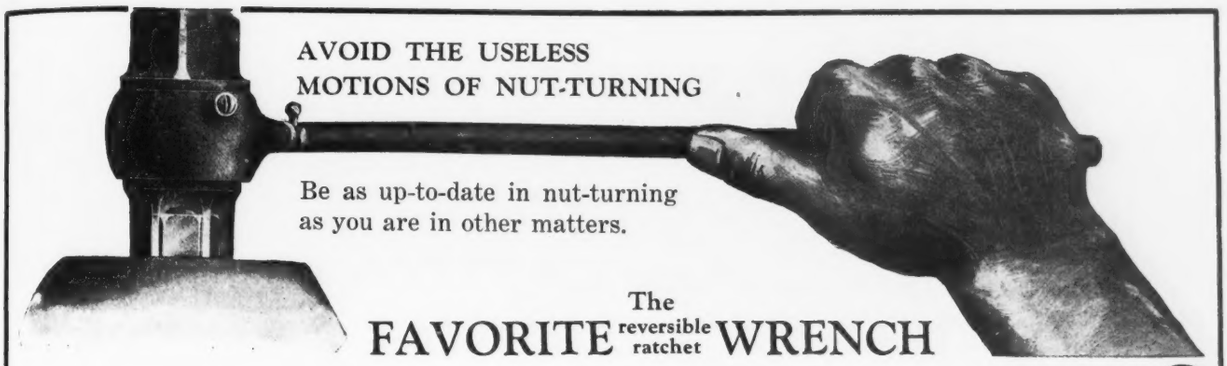

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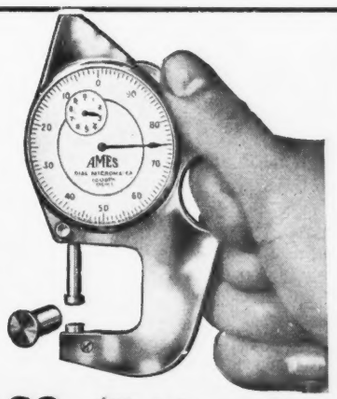

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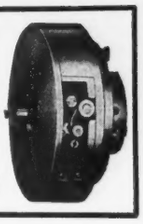

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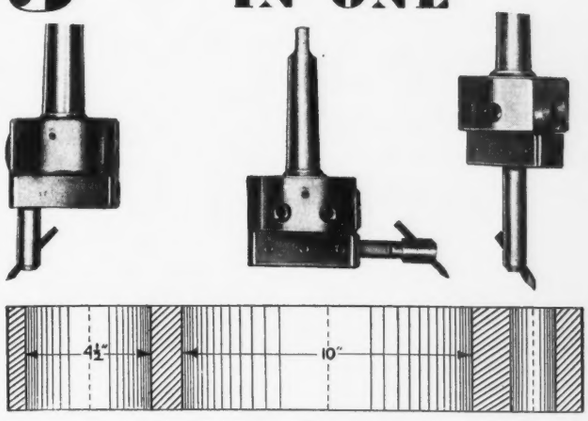

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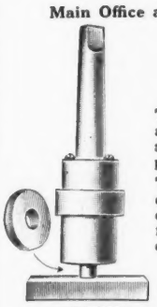

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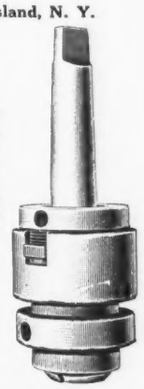

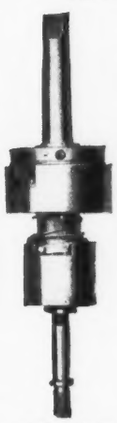

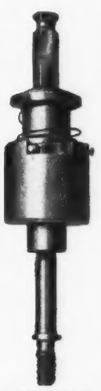

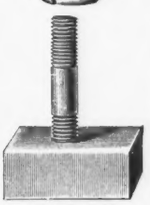

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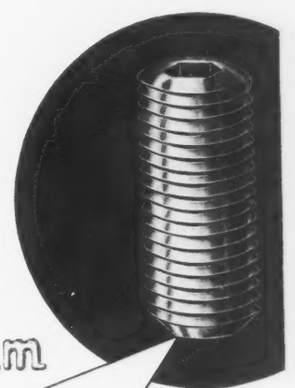

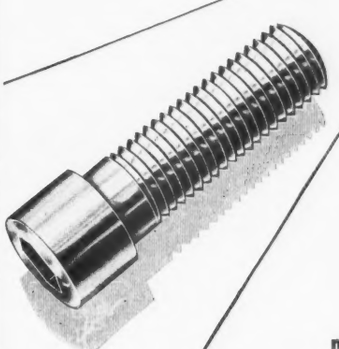

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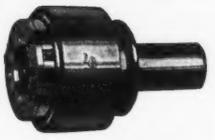

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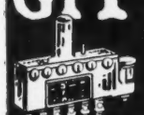

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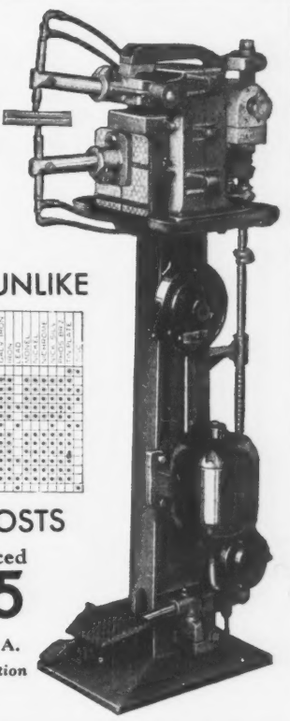

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